INSTALLATION RESTORATION PROGRAM (IRP) PRELIMINARY ASSESSMENT OF THE 291st COMBAT COMMUNICATIONS SQUADRON RADAR PAD AT GENERAL LYMAN FIELD

291st COMBAT COMMUNICATIONS SQUADRON
HILO AIR NATIONAL GUARD STATION
HAWAII AIR NATIONAL GUARD
HILO, HAWAII

JANUARY 1995

AIR NATIONAL GUARD

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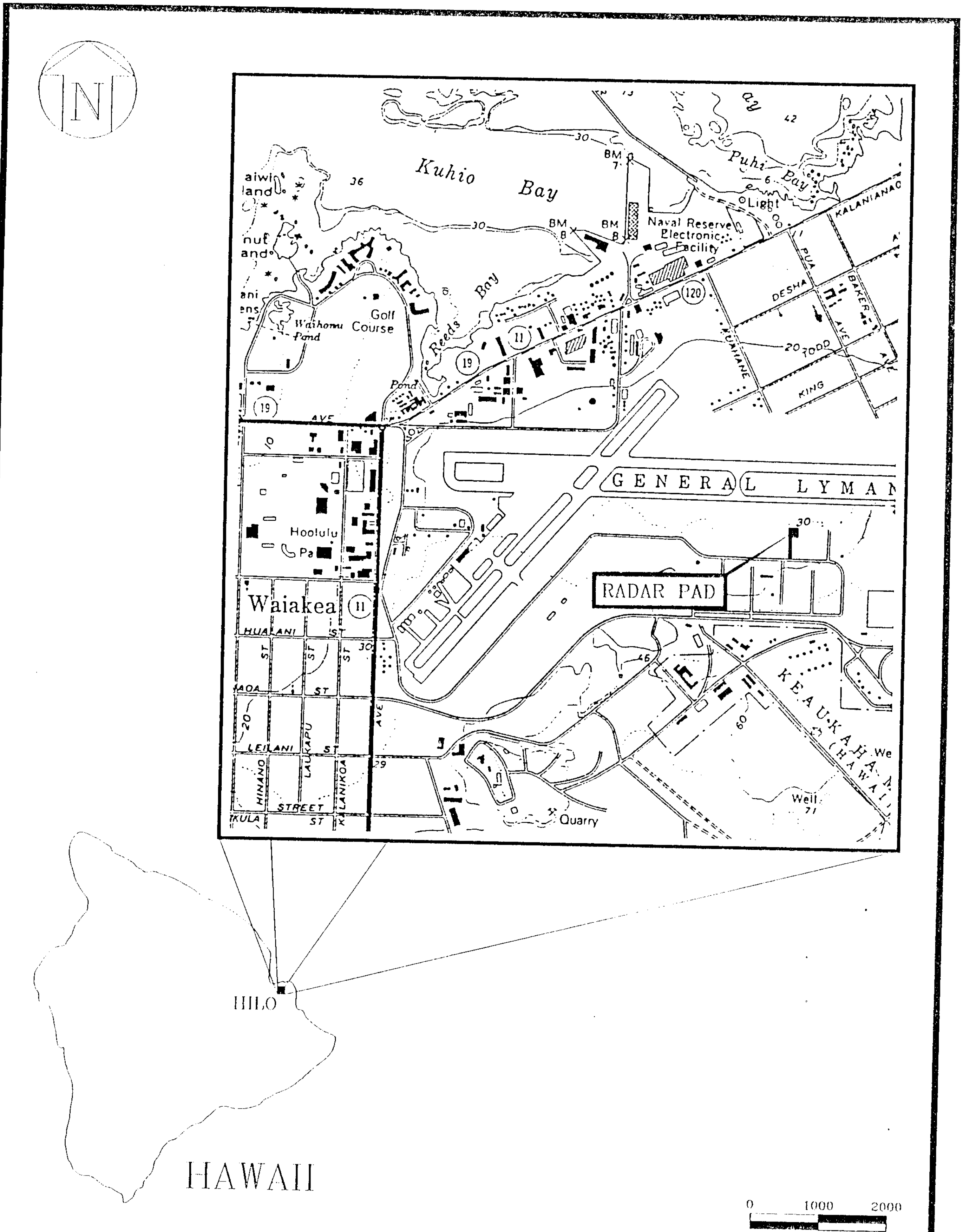

SOURCE: USGS 7.5' TOPOGRAPHIC MAP, HILO, HAWAII 1981.

INSIDE FRONT COVER

E_HILO_SITE

STATION LOCATION MAP
291st Combat Communications Squadron
Radar Pad at General Lyman Field
Hilo, Hawaii

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JANUARY 1995

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291st COMBAT COMMUNICATIONS SQUADRON
HILO AIR NATIONAL GUARD STATION
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HILO, HAWAII

JANUARY 1995

Prepared For

AIR NATIONAL GUARD READINESS CENTER
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Prepared By

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Radar Pad at General Lyman Field
291st Combat Communications Squadron
Hawaii Air National Guard
Hilo, Hawaii

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LIST OF ACRONYMS

AFB	Air Force Base
ANG	Air National Guard
ANGRC/CEVR	Air National Guard Readiness Center Installation Restoration Programs Branch
AOC	Area of Concern
ARARs	Applicable or Relevant and Appropriate Requirements
CBCS	Combat Communications Squadron
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
DQO	Data Quality Objectives
EO	Executive Order
FFS	Focused Feasibility Study
FS	Feasibility Study
GCA	Ground control approach
HIANG	Hawaii Air National Guard
HM/HW	Hazardous Materials/Hazardous Waste
IRP	Installation Restoration Program
MSDS	Material Safety Data Sheet
MSL	Mean sea level
NPL	National Priorities List
OpTech	Operational Technologies Corporation
PA	Preliminary Assessment
PL	Public Law
QA/QC	Quality Assurance/Quality Control
RA	Risk Assessment
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
R&D	Research and Development
RI	Remedial Investigation
RM	Remedial Measure
SARA	Superfund Amendments and Reäuthorization Act of 1986
SCS	Soil Conservation Service
SI	Site Investigation
USAF	United States Air Force
USC	United States Code
USEPA	United Station Environmental Protection Agency
USGS	United States Geologic Survey
UST	Underground Storage Tank

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INSTALLATION RESTORATION PROGRAM
PRELIMINARY ASSESSMENT

EXECUTIVE SUMMARY

A. Introduction

The Air National Guard Readiness Center (ANGRC), Installation Restoration Programs Branch (CEVR) has the responsibility for managing the Installation Restoration Program (IRP) on all property the Air National Guard (ANG) maintains. In April 1994, a Preliminary Assessment (PA) for the 291st Combat Communications Squadron (CBCS) radar pad located on General Lyman Field, Hilo, Hawaii was initiated by personnel from the ANGRC/CEVR. Operational Technologies Corporation (OpTech) of San Antonio, Texas, was tasked by the ANGRC/CEVR to conduct the Preliminary Assessment at the Station. The PA included:

- An on-site visit by OpTech and ANGRC personnel on April 13, 1994, and interviews with personnel of the 291st CBCS and knowledgeable personnel at Hickam Air Force Base (AFB) and Fort Ruger;

- The acquisition and analysis of pertinent information and records on hazardous materials use and hazardous waste generation and disposal at the Station;

- The acquisition and analysis of available geologic, hydrologic, meteorologic, and environmental data from pertinent Federal, State, and local agencies; and

- An assessment of the Station to determine if areas of concern (AOCs) exist which may have been contaminated with hazardous materials/hazardous wastes (HM/HW).

B. Major Findings

The 291st CBCS radar pad at General Lyman Field is a concrete pad with no developed features other than electrical and telephone connections. The pad was regularly used as a ground control approach (GCA) training facility from the 1980s until early 1991. Interviews with squadron personnel revealed no history of chemical use, storage or disposal at the pad during training

exercises, with one exception. Approximately 5 gallons of copper sulfate were spread along the edges of the radar pad every two weeks to increase the electrical grounding efficiency for the unit's mission radar. No other confirmation of this usage was noted.

Interviews were conducted with current 291st CBCS personnel and several knowledgeable personnel at Hickam AFB and Fort Ruger, Hawaii. As a result of these interviews and a field survey, no area at the radar pad was identified as potentially contaminated with HM/HW.

C. Conclusions

Information obtained from interviews with knowledgeable former and present Station personnel resulted in the identification of no area at the radar pad at General Lyman Field that is potentially contaminated with HM/HW.

D. Recommendations

No further IRP investigation is warranted since no formal Areas of Concern (AOCs) have been identified.

SECTION 1.0 INTRODUCTION

1.1 BACKGROUND

This Preliminary Assessment covers the Hawaii Air National Guard's 291st Combat Communications Squadron (CBCS) radar pad facility located at General Lyman Field, Hilo, Hawaii. As a site which has been utilized as a unit training facility by the 291st CBCS garrisoned at Hilo Air National Guard Station (ANGS) since the early 1980s, some operations at the pad potentially involved the use and disposal of materials and wastes which subsequently could be categorized as hazardous. Consequently, the Air National Guard Readiness Center has initiated the Installation Restoration Program (IRP) at the 291st CBCS radar pad. Coordination of the IRP at the Station is the responsibility of the 154th Group Environmental Management Office located at Hickam Air Force Base (AFB), Oahu, Hawaii.

1.2 INSTALLATION RESTORATION PROGRAM

The IRP is a comprehensive program designed to:

- Identify and fully evaluate suspected problems associated with past hazardous waste disposal and/or spill sites on Department of Defense (DoD) installations; and

- Control hazards to human health, welfare, and the environment that may have resulted from these past practices.

During June 1980, the DoD issued a Defense Environmental Quality Program Policy Memorandum (DEQPPM 80-6) requiring the identification of past hazardous waste disposal sites on DoD installations. The policy was issued in response to the Resource Conservation and Recovery Act (RCRA) of 1976 and in anticipation of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law (PL) 96-510 of 1980, commonly known as "Superfund." In August 1981, the President delegated certain authority specified under CERCLA to the Secretary of Defense through an Executive Order (EO 12316). As a result of EO 12316, the DoD revised the IRP by issuing DEQPPM 81-5 on December 11, 1981, which reissued and amplified all previous environmental directives and memoranda.

Although the DoD IRP and the U.S. Environmental Protection Agency's (USEPA) Superfund Programs were essentially the same, differences in the definition of program activities and lines of authority existed. These differences were rectified with the passage of the Superfund Amendments and Reauthorization Act (SARA, PL-99-499) of 1986. On January 23, 1987, a Presidential Executive Order (EO 12580) was issued which effectively revoked EO 12316 and implemented the changes promulgated by SARA.

The most important changes put into effect by the SARA legislation include:

- Section 120 of SARA provides that Federal facilities, including those within the DoD, are subject to all provisions of CERCLA/SARA concerning site assessment, evaluation under the National Contingency Plan (40 CFR 300), listing on the National Priorities List (NPL), and removal/remedial actions. The DoD must therefore comply with regulations and criteria promulgated by USEPA under Superfund authority.

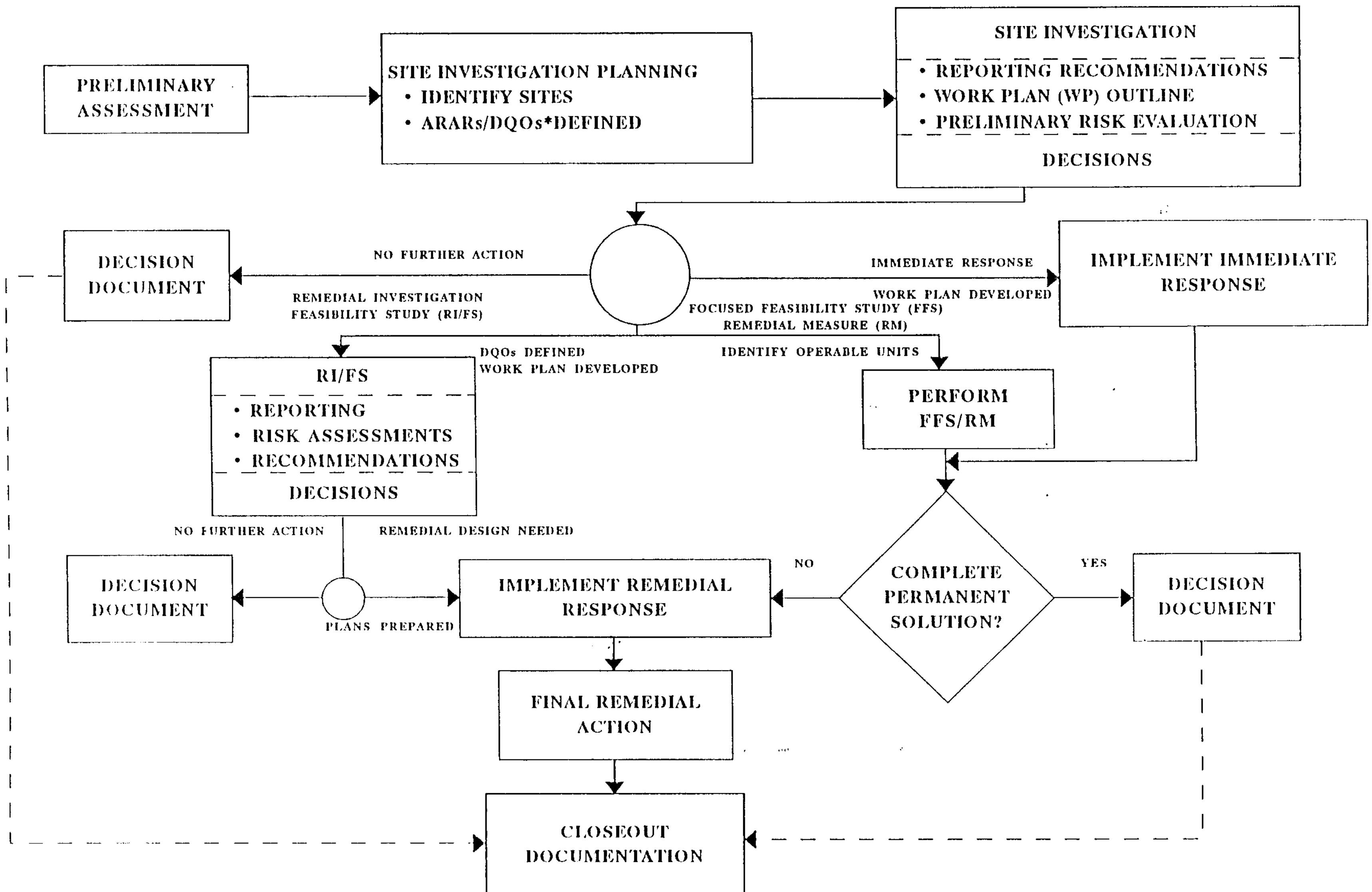
- Section 211 of SARA also provides continuing statutory authority for the DoD to conduct its IRP as part of the Defense Environmental Restoration Program (DERP). The statutory authority was emplaced by adding Chapter 160, Sections 2701 - 2707 to Title 10, United States Code (10 USC 160).

- SARA also stipulates that terminology used to describe or to otherwise identify actions carried out under the IRP shall be substantially the same as the terminology of the regulations and guidelines issued by the USEPA under their Superfund authority.

As a result of SARA, the operational activities of the IRP are currently defined and described in the following sections and are illustrated in Figure 1.1.

1.3 PURPOSE

The purpose of this Preliminary Assessment under the IRP is to identify practices involving suspected problems associated with past waste handling and disposal procedures and spill sites at the 291st CBCS radar pad.



* DQOs - DATA QUALITY OBJECTIVES
  ARARS - APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

FIGURE 1.1

HILO\FLOWDIAG

FLOW OF INSTALLATION RESTORATION PROGRAM TASKS
291st Combat Communications Squadron
Radar Pad at General Lyman Field
Hilo, Hawaii

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The potential for migration of hazardous contaminants was evaluated by visiting the garrison location for the 291st CBCS, reviewing existing environmental data, analyzing records concerning the use and disposal of hazardous materials and the generation of hazardous wastes, conducting interviews with current and past installation personnel who have knowledge of historical waste handling and disposal techniques and practices, and screening available sources to obtain preliminary data concerning the suspected contamination. Additionally, available information within the public domain was gathered to obtain sufficient data to establish the environmental setting at the site.

1.4 SCOPE

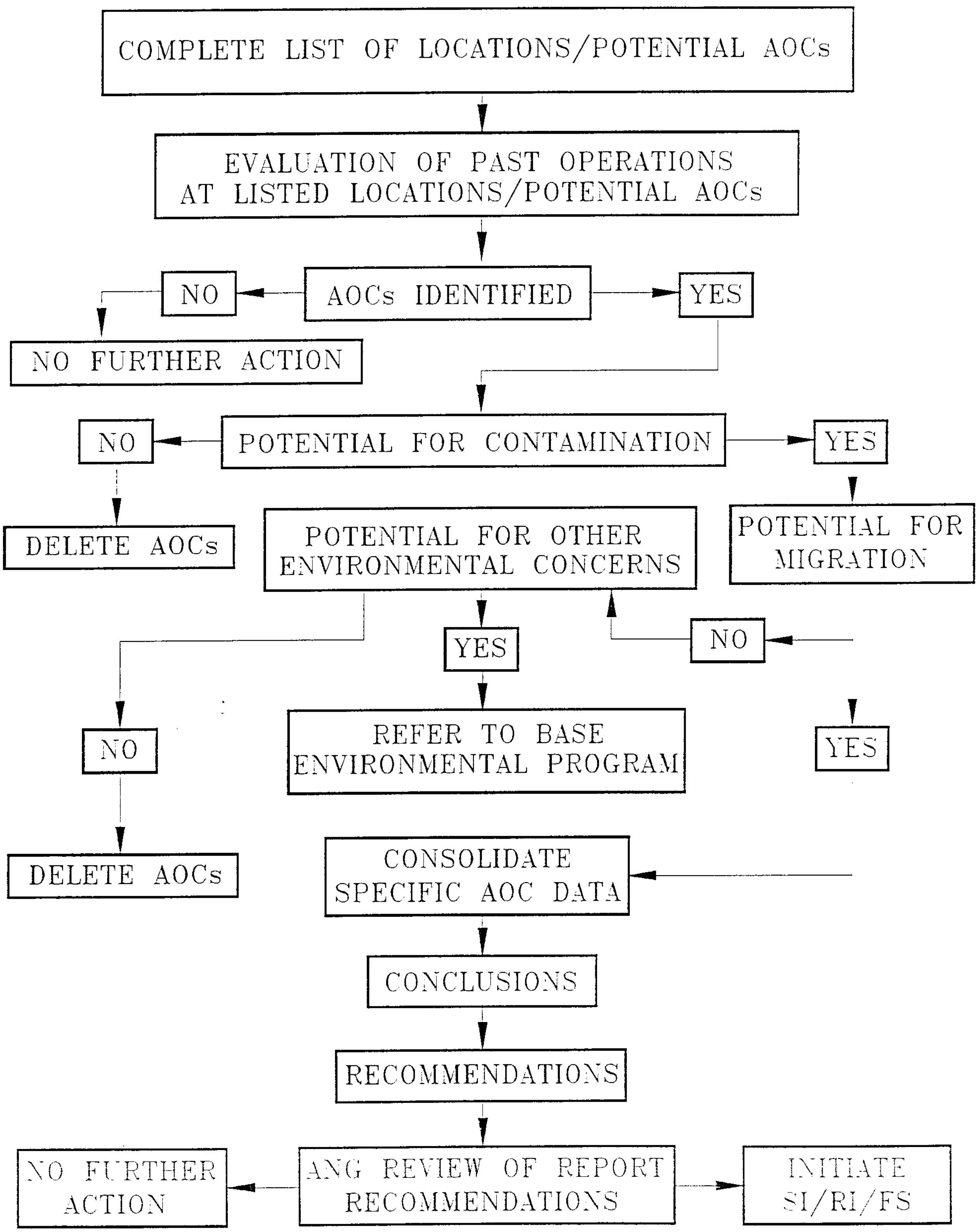
The scope of the PA was limited to the identification of property at and under the primary control of the 291st CBCS and the evaluation of potential receptors. The PA included:

- An on-site visit to the radar pad on April 13, 1994;
- Interviews with personnel of the 291st CBCS at the Hilo ANGS and with knowledgeable personnel at Hickam AFB and Fort Ruger;
- The acquisition of records and information from the 291st CBCS on past and present hazardous materials use, waste handling practices, and waste disposal at the radar pad site; and
- The acquisition of available information such as geological, hydrological, meteorological, land use and zoning, critical habitat, and related data from Federal, State, and local agencies.

1.5 METHODOLOGY

The PA began with an inbriefing with key Hawaii Air National Guard personnel to explain the purpose of the PA and to solicit their support during the information gathering phases. Mission support operations that may have used hazardous materials were given questionnaires to fill out listing estimated quantities of HM/HW historically used in their shops, and the methods of disposal. Overall PA methodology is depicted in Figure 1.2.

DECISION TREE



SOURCE: ANGRC/CEVR, 1993.

FIGURE 1.2 FORMS\PAMCADJ3	PRELIMINARY ASSESSMENT METHODOLOGY CHART 291st Combat Communications Squadron Radar Pad at General Lyman Field Hilo, Hawaii	OPTECH OPERATIONAL TECHNOLOGIES CORPORATION JANUARY 1995

Detailed geological, hydrological, and meteorological data, and population, land use, and environmental data for the area surrounding the General Lyman Field area were obtained from appropriate Federal, State, and local agencies. A listing of outside agencies contacted is included in Appendix A.

SECTION 2.0 INSTALLATION DESCRIPTION

2.1 LOCATION

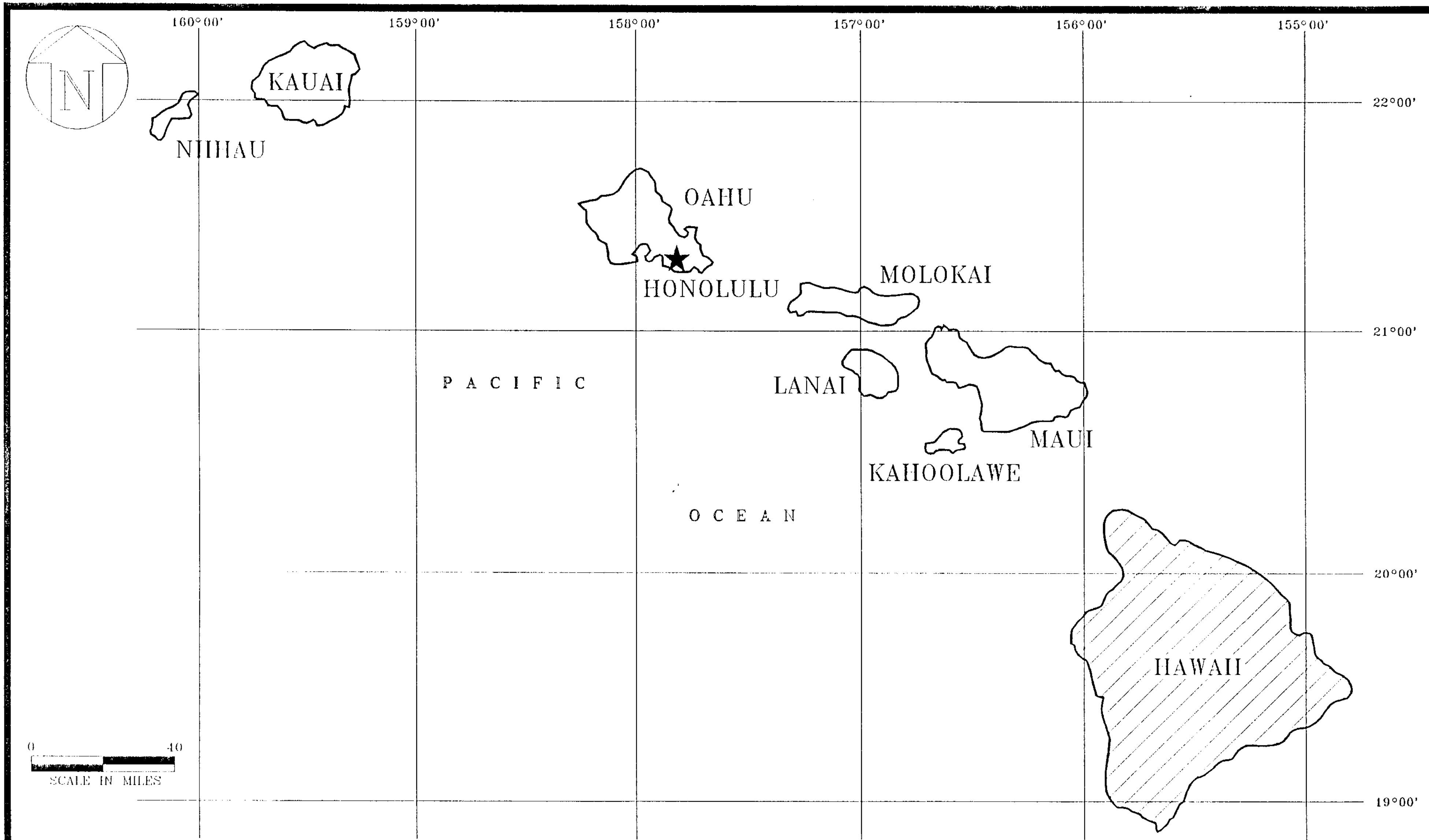
The 291st CBCS radar pad site is located on General Lyman Field (also known as Hilo International Airport) on the island of Hawaii. The islands of the state of Hawaii are the easternmost members of the Hawaiian Island Chain, and the island of Hawaii lies at the southeast end of this chain (Figure 2.1).

General Lyman Field, which is currently a commercial airport, is located on the coastal plain on the east coast of the island (Figure 2.2). The radar pad occupies approximately 1.42 acres and is less than a mile inland from the Pacific Ocean.

2.2 ORGANIZATION AND HISTORY

The 291st CBCS radar pad is located on property currently owned by the State of Hawaii Department of Transportation, Airports Division. During World War II (between 1941 and 1945), over 2,000 acres of land was acquired by the U.S. Army and U.S. Navy southeast of Hilo. The Hilo Airport (subsequently named General Lyman Field) was contained within this area and later became the site of U.S. Army Air Corps and U.S. Naval Air Station facilities during the war. According to a General Layout Plan of Army and Navy Facilities dated June 1944, the current 291st CBCS radar pad site was formerly the foundation of Army Building A300 (a mess hall) on Wright Avenue just south of the east/west runway. Facilities in the immediate area of Building A300 consisted of several rows of barracks, latrines, and two additional mess halls (see Figure 2.3).

In 1952, the U.S. government transferred General Lyman Field and a number of surrounding parcels to the Territory of Hawaii and the Hawaiian Homes Commission. The site was subsequently divided into numerous parcels, principally owned by the State Department of Transportation, the Hawaii National Guard, and the Department of Hawaiian Home Lands. Hilo International Airport now occupies 923 acres, with the Hawaii National Guard properties (known as Keaukaha Military Reservation) occupying 442 acres south of the airport. Additional facilities in the immediate area include a county dump, several quarries, and numerous farms, businesses, and residences.



SOURCE: SOIL SURVEY OF THE ISLAND OF HAWAII, STATE OF HAWAII, 1973

FIGURE 2.1

LYMAN\ISLANDS

LOCATION OF THE ISLAND OF HAWAII
IN THE STATE OF HAWAII
291st Combat Communications Squadron
Radar Pad at General Lyman Field
Hilo, Hawaii

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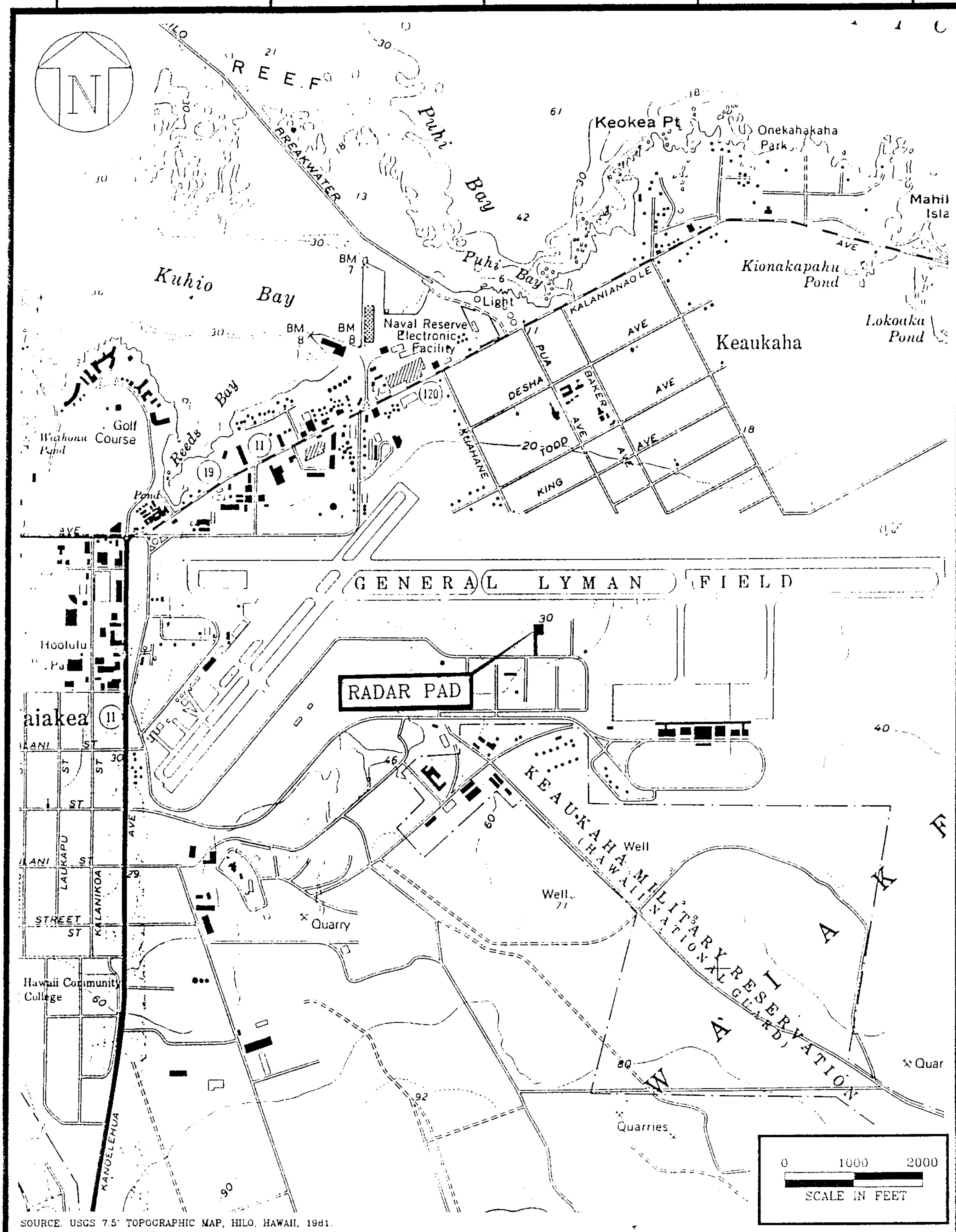

FIGURE 2.2

R\HILO\75TOPO

INSTALLATION LOCATION MAP
291st Combat Communications Squadron
Radar Pad at General Lyman Field
Hilo, Hawaii

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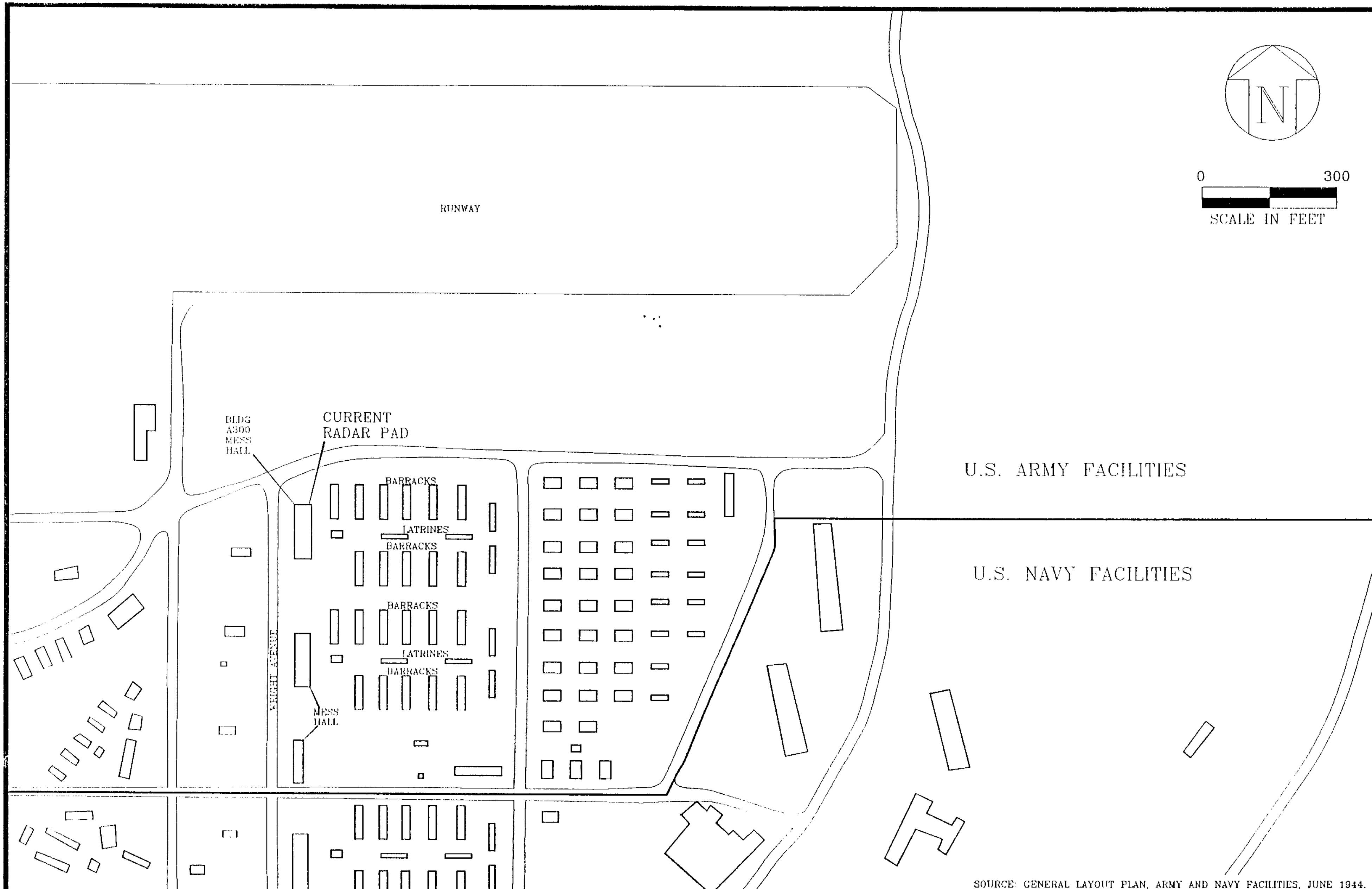

FIGURE 2.3

LYMAN\PRELYMAN

LAND USE, 1941–1945
291st Combat Communications Squadron
Radar Pad at General Lyman Field
Hilo, Hawaii

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After the World War II buildings were demolished, the former mess hall foundation, now the radar pad, was overgrown with native vegetation for a number of years. Eventually, when clearing the airport property of vegetation, the concrete pad was discovered.

During this period, the 201st CCSQ (now designated as the 291st CBCS) was searching for a site in close proximity to the airport to set up a ground control approach (GCA) radar training area. In April 1980, the State of Hawaii Department of Transportation granted permission to the Hawaii Air National Guard (HIANG) to occupy and use the pad parcel as a GCA training area. The 201st CCSQ's mobile GCA equipment was to serve as an air traffic control center to guide aircraft to safe landing during conditions of reduced visibility. An Environmental Impact Assessment, dated January 1, 1983, was conducted in preparation of the radar pad acquisition. Subsequent actions taken by the HIANG to occupy the site included clearing of tall grass and small trees that would obstruct the surveillance radar scan, and the installation of underground cable for telephone and electrical service. The radar pad was regularly used as a GCA training site by the 291st CBCS at Hilo ANGS until approximately February 1991. With the exception of the air traffic control function, the Squadron's mission has remained unchanged: to provide command and control communications for tactical air forces and support of emergency U. S. Air Force (USAF) requirements for communications facilities. Currently, the radar pad is used only occasionally for unit training activities.

2.3 SIGNIFICANT INFORMATION

The 291st CBCS radar pad is a 19,250-square-foot concrete pad located approximately 2,500 feet east of the crossings of the two runways at General Lyman Field and approximately 700 feet south of the east/west runway. Figure 2.4 illustrates the configuration of the radar pad.

The 291st CBCS radar pad currently has no developed features. There is a small cinder block wall with electrical and telephone terminals mounted on it on the southern edge of the pad. During unit training exercises, sanitation facilities are provided by a leased portable toilet. However, electric and telephone service is provided to the pad by underground cable installed in the utility easement running from the airport service road to the pad. A narrow line has been painted in a north/south direction across the radar pad; the line is used to align mission radar equipment with radar reflectors located across General Lyman Field. The airport service road is secured and accessible by authorized personnel only.

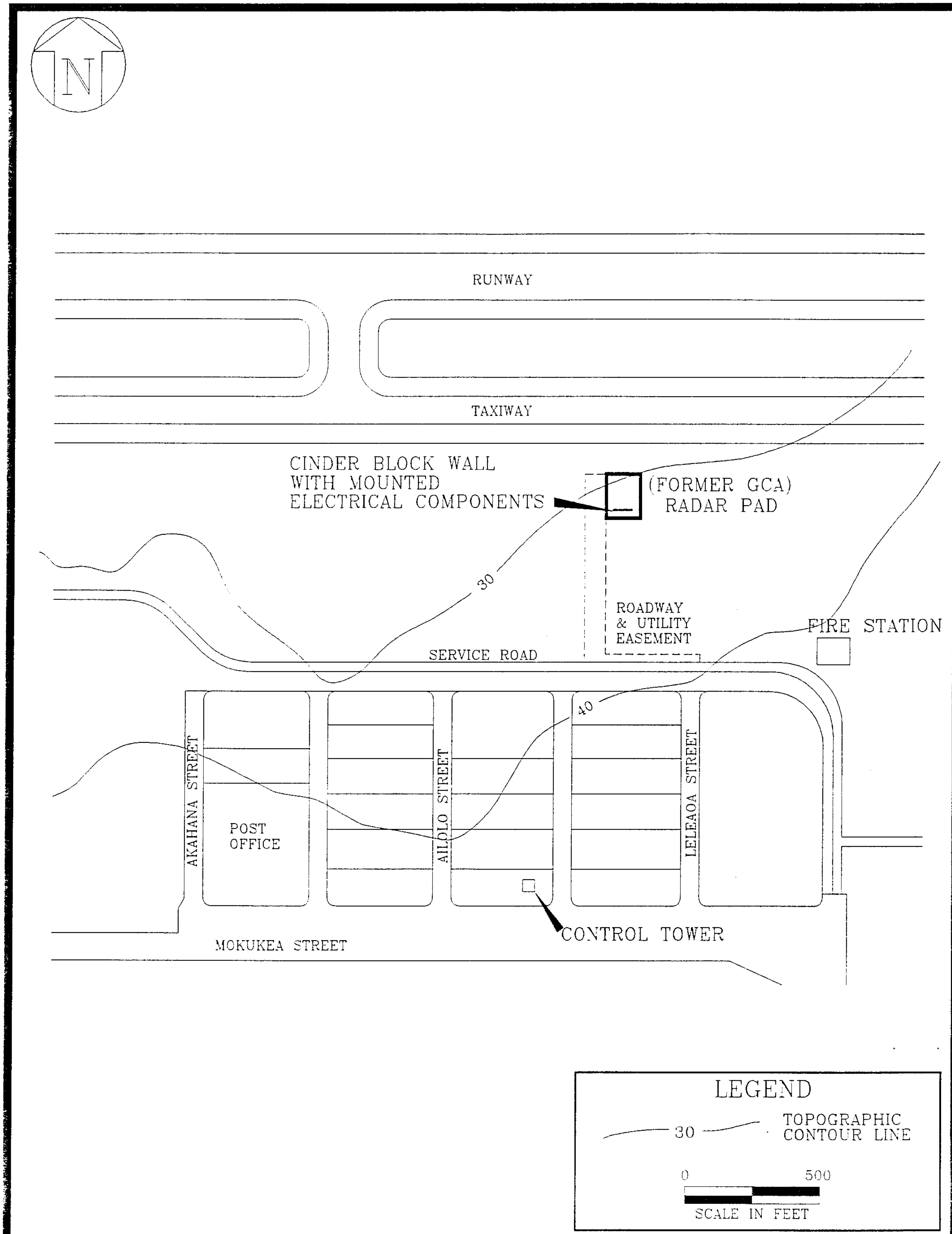

FIGURE 2.4

LYMAN\GENLYMAN

RADAR PAD
AT GENERAL LYMAN FIELD
291st Combat Communications Squadron
Radar Pad at General Lyman Field
Hilo, Hawaii

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Of particular note, the U.S. Army, Pacific Ocean Division, Corps of Engineers, Fort Shafter, Oahu, Hawaii conducted a DERP inventory project report for formerly used sites on General Lyman Field in November 1990. The inspection attempted to identify the presence and extent of any hazardous/toxic waste, unexploded ordnance, unsafe buildings or structures, and unsafe debris at General Lyman Field as a result of the military's occupation of the site during the period from February 1941 to July 1945. The field survey focused on areas where formerly used underground storage tanks (USTs), ordnance storage areas, transformers, cesspools, and unsafe structures were suspected to be located, according to former facility maps and discussions with the current site owners. The radar pad site is situated in an area which contained no industrial or munitions-related activity; the area contained only barracks, mess halls, and latrines for U.S. Army personnel during the war years. As such, it is assumed that hazardous wastes were neither stored nor disposed onsite. The DERP project report concluded that no remedial action was necessary for the General Lyman Field site.

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SECTION 3.0 ENVIRONMENTAL SETTING

3.1 METEOROLOGY

3.1.1 Climatic Features

Among the 50 states, Hawaii is the only state surrounded by the ocean and the only one within the tropics. Both of these facts contribute significantly to its climate. The populated islands of the State are comprised of the easternmost members of the Hawaiian Island Chain. All of the islands are bordered by fringing coral reefs, and all have coasts that consist in part of sea cliffs, some of which are 300 to 3,000 feet in height.

The mountains, especially those of great height on Hawaii and Maui, strongly modify the marine effect and result in conditions that are semi-continental in some localities. The result is climatic conditions of great diversity. The most prominent feature of the circulation of air across the tropical Pacific is the tradewind flow in a general northeast-to-southwest direction.

In general, the Hawaiian climate is characterized by a two-season year, by mild and fairly uniform temperature conditions everywhere but at high altitudes, by strikingly marked geographic differences in rainfall, by generally humid conditions and high cloudiness except on the driest coasts and at high elevations, and by a general dominance of tradewind flow, especially at elevations below a few thousand feet.

3.1.1.1 Winds

The dominance of the tradewinds and the influence of terrain give special character to the climate of the islands. Tradewinds provide a system of natural ventilation much of the time throughout most of the State and bring to the land, at least in the lower lying regions, the mildly warm temperatures that are characteristic of air that has moved great distances across the tropical seas. Areas on the leeward (or "kona") coasts, with reference to the tradewinds and topographically sheltered from them, include the Kona Coast of Hawaii and the Barking Sands area of Kauai.

The wind conditions in Hawaii are exceedingly complex. Though the tradewinds are fairly constant in speed and though they blow a high percentage of the time across the adjacent sea and onto the bordering lands, the relatively uniform tradewind flow is distorted and disrupted by the

mountains, hills, and valleyways. In addition, there are local wind regimes along many of the coasts and on the mountain slopes.

Over the ocean around Hawaii, average windspeeds are highest during the summer tradewind period. During the summer months (May through October), the ocean winds exceed 12 miles an hour 50 percent of the time; 80 to 95 percent of the time these winds are from the northeast quadrant. During the winter (from November through April), when tradewinds are not quite as prevalent, windspeeds are in excess of 12 miles per hour about 40 percent of the time. When the tradewinds are moderate or strong--generally in excess of 14 miles per hour--they dominate the flow of air across wide reaches of the lowlands.

Major storms are chiefly events of the winter season, and they may yield very high winds from any direction. In any major, wind-producing storm, the extreme windspeeds may vary radically from one place to another, due both to the peculiarities of the storm, and to the effects of terrain. (Blumenstock and Price, 1974; Stearns, 1966)

3.1.1.2 Humidity and Cloudiness

Because of the diversity of valleys, hills, and mountains, the moisture distribution within the air that moves across Hawaii is far from uniform. Under tradewind conditions, there is very often a pronounced moisture discontinuity at heights of between 4,000 and 8,000 feet above sea level. In general, windward areas tend to be cloudier during the summer, when tradewind clouds are more prevalent, while leeward areas, which are less affected by tradewind cloudiness, tend to be cloudier during the winter, when general storms and frontal passages are more frequent. Except on high mountains, the general regime in Hawaii is one of high humidities, as compared with conditions in most other states. (Blumenstock and Price, 1974)

3.1.1.3 Precipitation

Among Hawaii's outstanding climatic features are the remarkable differences in rainfall over short distances. The principal cause of this remarkable variability is the orographic, or mountain-caused, rain that forms within the moist air from trade winds as it ascends and traverses the steep and high terrain of the islands. The resulting rainfall distribution, in the mean, closely resembles the topographic contours. The amount is greatest over windward slopes and crests and is least toward the leeward lowlands.

The northeastern sides of the mountains are usually wettest because of the prevailing wind. Maximum precipitation occurs between altitudes of 2,000 and 6,000 feet, depending upon the form and height of each island. Above 6,000 feet the precipitation deceases, making high peaks semiarid. As the winds descend the lee slopes, they become warmer, drying winds, causing arid and semiarid climates on the leeward sides of the islands. The annual rainfall ranges from 10 inches or less on the lee coasts to about 450 inches on the wettest belts.

On the Island of Hawaii, the zones of highest rainfall on the flanks of the large, high mountains of Haleakala, Mauna Loa, and Mauna Kea lie at elevations of 2,000 to 4,000 feet. Several times a year, on the average, and almost always between October and May, major storms may deposit a foot or more of snow on the upper slopes of one or more of Hawaii's highest mountains.

The average rainfall in Hilo varies from about 113 inches in the summer season to 160 inches a year in the winter season. At Hilo, the average monthly rainfall for the winter season is 13.31 inches, while the average monthly rainfall for the summer season is 9.48 inches. The amount of rainfall recorded in the wettest month (March) was 15.45 inches, while the driest month (June) recorded 6.80 inches. In Hilo, the highest annual total was 207 inches of rainfall, the lowest 72 inches. Rainfall variability is far greater during the winter, when occasional storms contribute appreciably to rainfall totals, than during summer, when tradewind showers provide most of the rain. (Blumenstock and Price, 1974; Stearns, 1966)

Rainfall is the principal source of recharge. However, the distribution of rainfall is not the same in different island locales, and depends largely on the rainfall quantity and variability, and the absorption ability of the land surface. Of approximately 7,335 million gallons per day of rainfall which falls in the drainage basin which includes the Hilo area, approximately 24 percent is lost to evapotranspiration, 34 percent is runoff, and 42 percent is groundwater recharge. (Takasaki, 1978)

3.1.1.4 Temperatures

There are essentially two seasons in Hawaii, summer and winter. During the summer months, temperatures range from 70°F to 88°F and the weather is warm and dry. Northeasterly tradewinds are also present most of the time. During the winter season, the weather is cooler, and temperatures range from 60°F to 83°F. Elevation also affects the temperature. An increase

of every 1,000 feet realizes a decrease in temperature of 4°F. The maximum temperature rarely exceeds 90°F, and the minimum hovers around 50°F.

Hilo, the principal city on the island of Hawaii, lies 40 feet above sea level in the windward lowlands on the east side of the island on Hilo Bay. In Hilo, July and August are the warmest months, with average daily highs and lows of 83°F and 68°F, while January and February, the coolest months, have highs of 80° and lows of 63°F. (Blumenstock and Price, 1974)

Temperature variations throughout the islands, except at extremely high altitudes, are very slight because of the small variation in solar energy and the virtually constant flow of fresh ocean air across the islands. The rugged configuration of the islands produces marked variations in conditions from one locality to another. Thus, the climatic pattern reflects not only such dynamic elements as tradewind flow, the passage of storms, and the seasonal rhythms of daylight and of solar heating, but also the static element of topography.

3.2 PHYSIOGRAPHIC SETTING

The island of Hawaii, the southernmost island in the island chain, is 93 miles long and 76 miles wide, with an area of approximately 4,030 square miles. The maximum elevation on Hawaii is 13,796 feet.

The 291st CBCS radar pad site is located on the coastal plain near Hilo Bay along the east coast of the island. The island of Hawaii's dominant physiographic features are the large mountains of Mauna Loa and Mauna Kea, both of which rise to over 13,000 feet above mean sea level (MSL) and both of which have suffered only slight erosion. The topography of the island reflects the volcanic activity. In the northern and eastern sections where volcanic flows have not occurred recently, the terrain has been eroded by rivers and streams. In the southern section the terrain is undissected, is quite barren, and reveals large areas of exposed lava.

3.2.1 Topography and Drainage

The 291st CBCS radar pad at General Lyman Field is located at 19°43' North latitude, 155°03' West longitude approximately three miles southeast of Hilo, and less than one mile inland from the Pacific Ocean. Elevations at General Lyman Field range from approximately 50 feet above mean sea level (MSL) at the south boundary to approximately 20 feet MSL at the north

boundary, and the area topography slopes gradually toward Hilo Bay. The radar pad, at an elevation of 30 feet above MSL, is not located in a flood-prone area.

The larger islands were subdivided into hydrographic areas by the Hawaii Water Authority in 1959. The boundaries of the areas are based on topography and generally outline the major surface drainage basins. The major drainage basins on the Island of Hawaii are shown in Figure 3.1.

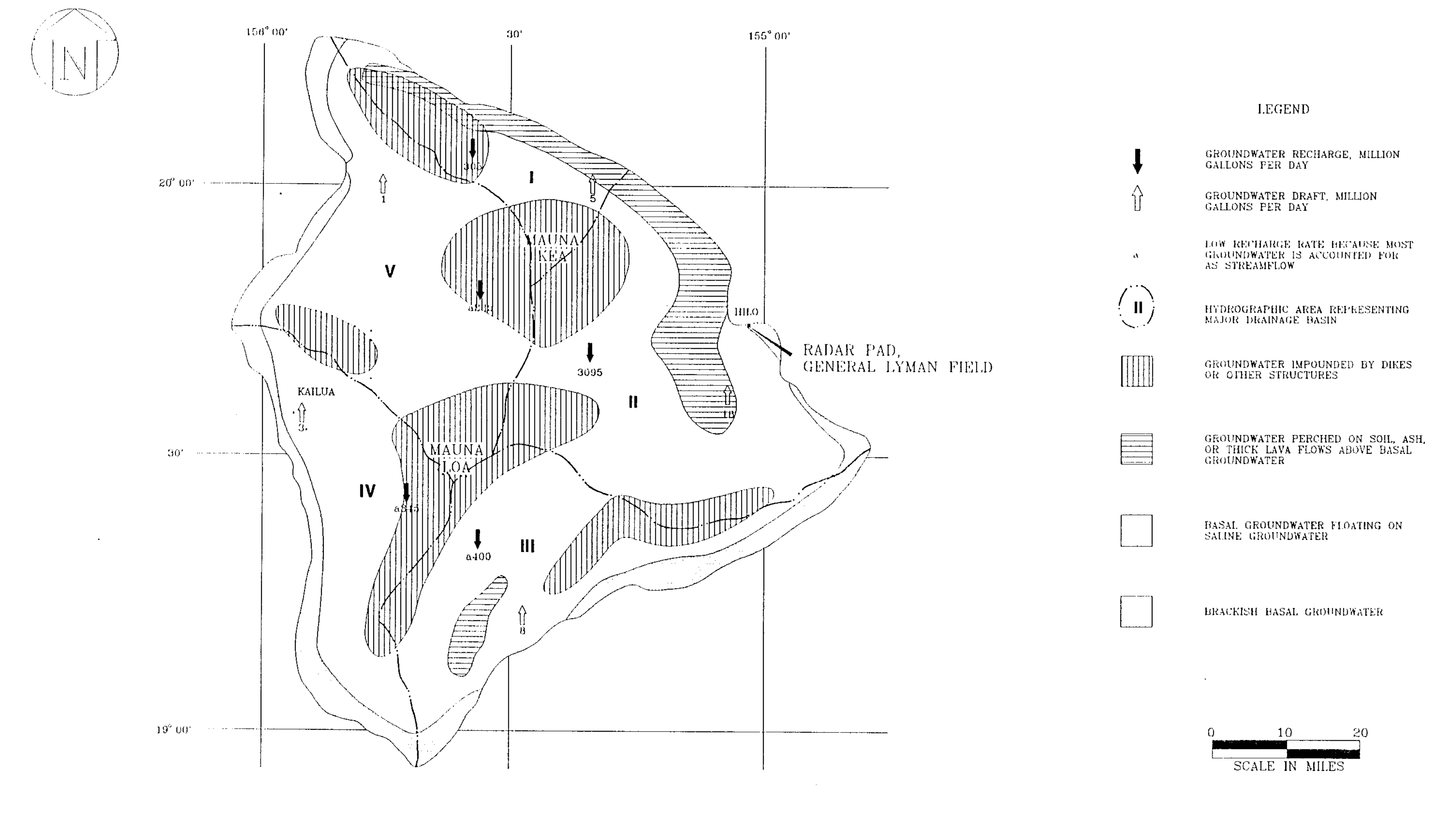
3.3 GEOLOGY

3.3.1 Regional Geology

The Earth's solid surface is divided into a dozen or so more or less rigid plates, 35 to 70 miles thick, which move laterally relative to each other over a zone of low rigidity in the upper part of the Earth's mantle. These plates have several types of boundaries, one being spreading boundaries in which adjacent plates are moving away from each other. These spreading boundaries lie mostly along the great series of ridges which girdle the Earth, largely on the ocean floors, and seismic activity along such ridges contributes to the source of new crustal material.

Hawaii is located within the Pacific Plate, and researchers agree that Hawaii is underlain by what is called a mantle plume. Mantle plumes are relatively narrow columns of hot mantle that rise from deep within the mantle. These plumes are found within plates and at divergent boundaries between plates. It has been recognized, on the basis of the degree of weathering and erosion, that the Hawaiian volcanoes decrease progressively in age from the northwest to the southeast, and it is believed that this is the result of the northwestward movement of the Pacific plate across a hot, magma-generating spot in the mantle, magma rising through the plate to form a volcano. The center of the plume underlying Hawaii is located close to Mauna Loa and Kilauea on the island of Hawaii. Radioactive dating of the lavas of Hawaiian volcanoes has confirmed the general southeastward decrease in age.

The Hawaiian Islands are a chain of shield-shaped basaltic domes built over a fissure 1,600 miles long in the ocean floor. The feature has existed since at least early Tertiary (see Geological Time Scale in the Glossary) and probably longer. The lava now rises along tension cracks bounding blocks strung out linearly from southeast to northwest.



SOURCE: MODIFIED FROM TAKASAKI, 1978.

FIGURE 3.1

HILO\BASINS

MAJOR DRAINAGE BASINS AND GROUNDWATER RESERVOIRS, ISLAND OF HAWAII
291st Combat Communications Squadron
Radar Pad at General Lyman Field
Hilo, Hawaii

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Fissure eruptions characterize Hawaiian volcanoes. Seismic records indicate that the magma starts rising from the mantle about 35 miles below the surface and forms a reservoir within the crust at a depth of several miles. From there it finds its way to the surface through narrow dikes (areas of igneous intrusion). The usual eruption is preceded by a local earthquake as the ground opens to allow the exit of the magma. The fissures are a few inches to a few feet wide, and, during the rapid dome-building epoch, are limited to definite rift zones. The widest single dike known in Hawaii is 40 feet across; the average width is about 2 feet. Eruptions often begin with a lava fountain which is caused by frothing at the top of the lava column when pressure on the enclosed gases is released. Rivers of pahoehoe pour from the fissure, but as it flows down the mountainside, the lava usually changes to Aa. Recorded eruptions have lasted from a few hours to 18 months, and the flows have ranged in length from a few feet to 35 miles.

Hawaiian eruptions are self-extinguishing because eruption of lava to the surface is far more rapid than its replenishment from the source far below. Exposed parts of the Hawaiian volcanoes contain by volume less than one-half of 1 percent of explosive debris, thus indicating the dominance of lava outpourings. The flows range from a few inches to 900 feet in thickness, but most are from 10 to 30 feet. The main bulk of the domes consists of lava beds dipping 3° to 10° away from their source and rarely separated even by thin soil beds. Thin soils between flows in some volcanoes show that the time interval between eruptions lengthened toward the close of the dome-building epoch. Many of the soil beds are decomposed vitric tuff which, during the early phase of eruption, generally is deposited in small quantities by lava fountains near the vents.

Landscape features of volcanic origin may be either positive forms, the result of accumulation of volcanic materials, or negative forms, the result of lack of accumulation or of collapse. Both features are found in the State of Hawaii. Fissure eruptions which occur repeatedly along the same zone of fissures result in a broadly rounded dome-shaped hill or mountain known as a shield volcano. Shield volcanoes consist almost wholly of innumerable superimposed thin lava flows. Small bowl-shaped depressions formed by explosion are known as craters, and most of them are found on the flanks of volcanic cones. A larger depression at the summit of volcanic cones is formed by collapse of the summit as the support beneath it is removed by the rapid withdrawal of magma. A depression of this sort is called a caldera.

Phreatic and phreatomagmatic explosions have occurred sparingly. Such violent explosions may throw dust and ash high into the stratosphere, where it may drift for thousands of miles (ash from eruptions of Iceland has fallen in the streets of Moscow). Most of the solid fragments in

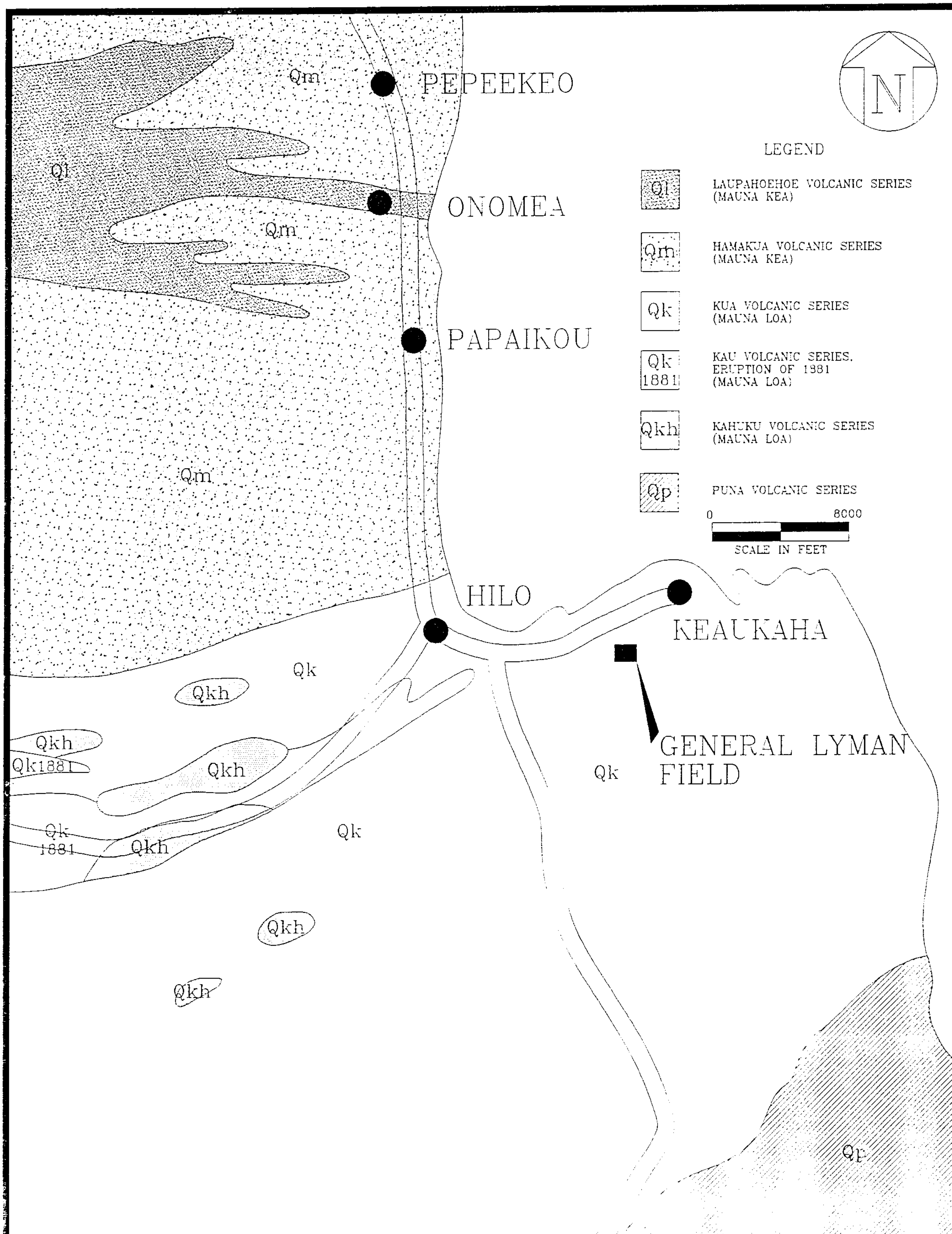
the cloud settle out within a few days, and nearly all within a few weeks, but some finely divided material may remain suspended in the stratosphere for more than a year. (McGraw-Hill Encyclopedia of the Geological Sciences, 1978; and The Encyclopedia of Structural Geology and Plate Tectonics, 1987)

3.3.2 Local Geology

The Island of Hawaii, at the eastern end of the Hawaiian Islands, is geologically the youngest in the island chain. The island was built by lavas poured from five volcanoes--Mauna Kea, Mauna Loa, Hualalai Volcano, Kohala Mountain, and Kilauea Volcano. Only the two major volcanos, Mauna Kea and Mauna Loa, have impacted the regional geology and are discussed here. Mauna Kea, the highest of the volcanic domes at 13,784 feet, rises sharply to the northwest from the lowlands. The dome is 30 miles across and studded with cinder cones, most of which are near the top and clustered into zones, indicating that the volcano was built over rifts trending eastward, southward, and westward. The volcanics of Mauna Kea are divided into two series. The older forms the major part of the mountain and is chiefly primitive olivine basalts, while the younger series are all andesites. Mauna Kea became extinct in the Holocene (or Recent) Epoch. Rocks of the Hamakua volcanic series, capped by Pahala ash, are found south and west of Hilo.

Mauna Loa, an active volcano which lies southwest of Hilo, is a shield-shaped dome about 60 miles long and 30 miles wide and is one of the most prolific lava producers on earth. During the past 150 years, Mauna Loa has averaged one outbreak in the caldera every four years, and has produced a lava flow every seven years. The rocks of Mauna Loa are divided into three units, all olivine basalts. The prehistoric lava member flows were extruded from late Pleistocene to Holocene prehistoric times, while the historic member of the Kau volcanic series comprises the lavas erupted since 1832.

The General Lyman Field area was built by lava flows from Mauna Loa, which lies southwest of Hilo. The Kau volcanic series found in the area are a result of such eruptions (see Figure 3.2). The Kau volcanic series are fairly fresh lavas, commonly bare and rocky in dry areas and rarely more than 25 feet thick. Mauna Loa has poured out numerous flows, the longest historical flow in 1859 which was 33 miles long and lasted 10 months. These prehistoric and historic lavas, from the late Pleistocene and Holocene epochs, are found in the southern and eastern sections of Hilo. During another eruption in 1881, lava stopped in the outskirts of Hilo after flowing 29 miles. An eruption of Mauna Loa in 1940 extruded lava at a rate of 2,600,000



SOURCE: GEOLOGIC HIGHWAY MAP OF THE STATE OF ALASKA AND THE STATE OF HAWAII MAP NO 8

FIGURE 3.2	GEOLOGIC MAP	OPTECH
LYMAN SOILMAP	291st Combat Communications Squadron Radar Pad at General Lyman Field Hilo, Hawaii	OPERATIONAL TECHNOLOGIES CORPORATION JANUARY 1995

cubic yards per hour. The lavas include porphyritic and nonporphyritic Aa and pahoehoe basalts. Olivine and feldspar phenocrysts are abundant in the basalts. In addition, lava tubes and minor structures typical of recent lava flows are common. A lithologic description of the geologic units underlying Hawaii is provided in Table 3.1.

3.3.3 Soils

Soils classified at the site by the U. S. Department of Agriculture Soil Conservation Service (SCS) include lava flows and units of the Keaukaha series.

The Keaukaha series consists of well-drained, thin organic soils 2 to 12 inches deep, overlying pahoehoe lava bedrock. These soils occupy the low areas of Mauna Loa. They are at an elevation ranging from near sea level to 1,000 feet and receive from 90 inches to more than 150 inches of rainfall annually. The soil type found in the General Lyman Field area is classified as Keaukaha extremely rocky muck (rKFD), 6 to 20 percent slopes (see Figure 3.3). It is undulating to rolling and follows the topography of the underlying pahoehoe lava bedrock, which is found at a depth of 0 to 1 foot. Rock outcrops occupy about 25 percent of the area. The surface layer is very dark brown muck about 8 inches thick, is rapidly permeable, and is strongly acid. The pahoehoe lava is very slowly permeable, but water moves rapidly through the cracks. Runoff is medium, and the erosion hazard is slight. Keaukaha soils are used for woodland, pasture, and homesites.

3.4 HYDROLOGY

3.4.1 Groundwater

The water resources of the State of Hawaii, taken as a whole, are far greater than foreseeable future demands on them, but this is not so for the individual islands. Each and every island is independent with respect to water supply, and the occurrence and availability of water vary widely from island to island. Groundwater resources offer better prospects for supplying additional water needs in the future than the surface water resources. Rainfall is the principal source of groundwater recharge.

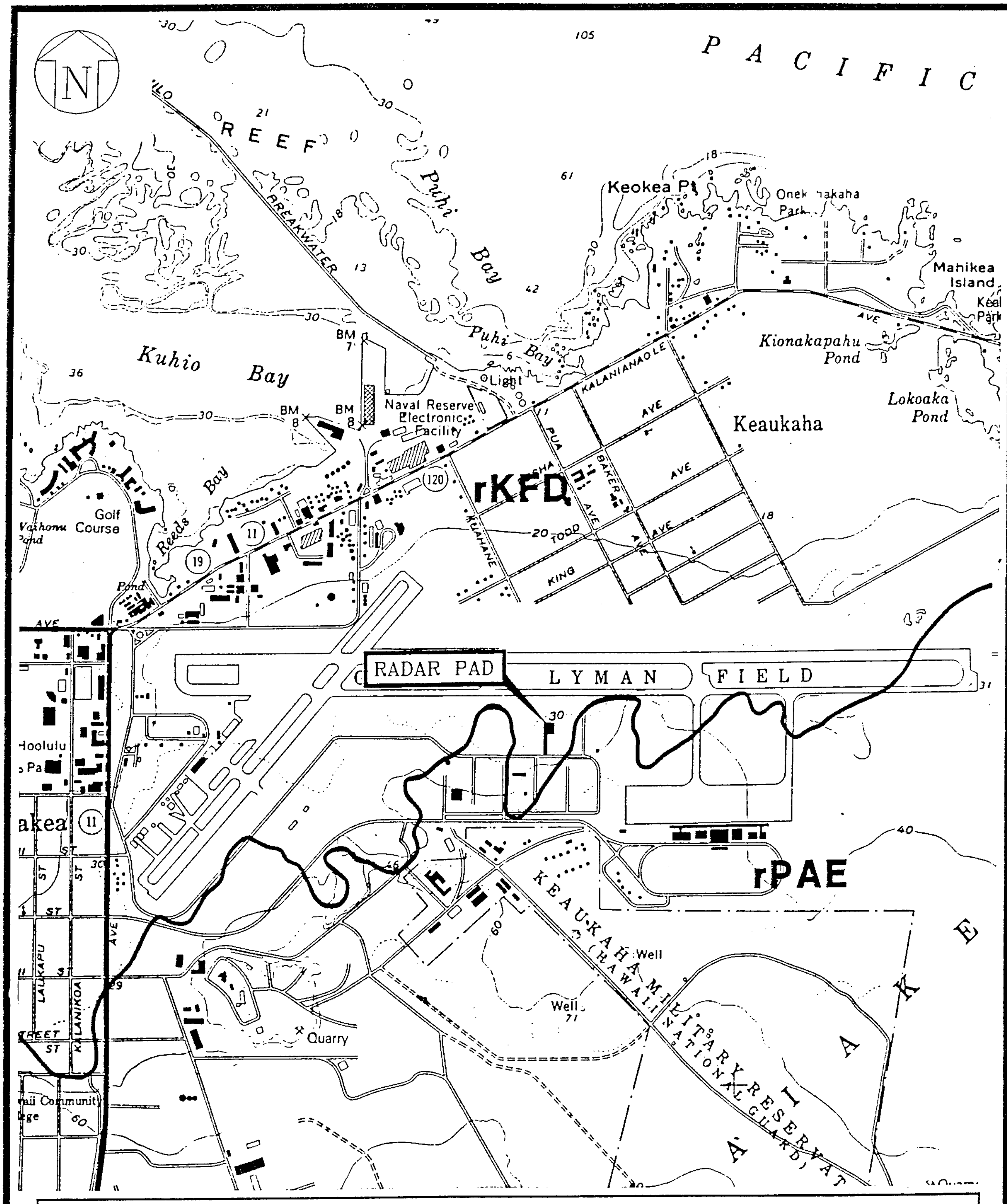
Hawaiian streams, in general, are short and steep, and runoff depends largely on the intensity and duration of rainfall. In areas where the infiltration capacity of the surface rocks is especially high, most rainfall is quickly absorbed, and there may be no runoff, except during intense

Table 3.1
Stratigraphic Rock Units in the Island of Hawaii

Age	Hualalai	Kohala Mountain	Mauna Loa	Kilauea	Mauna Kea
Historic	Historic member of the Hualalai volcanic series (1800-01)	Unconsolidated alluvium, dunes and landslides	Historic member of volcanic series (1832-1950) Mud flow of 1868	Historic member of the Puna volcanic series (1790-1965)	Ribbons of gravel and small alluvial fans
Recent	Prehistoric member of the Hualalai volcanic series		Dunes	Dunes	Upper member of the Laupahoehoe volcanic series
Late Pleistocene	Pahala ash (exposed on Waawaa volcanics only)	Fluvial conglomerates Pahala ash (not differentiated)	Prehistoric member of the Kau volcanic series Pahala ash	Prehistoric member of the Puna volcanic series Pahala ash	Glacial debris and fluvial conglomerates Lower member of the Laupahoehoe volcanic series **Local erosional unconformity** Pahala ash
Early and middle Pleistocene	Waawaa volcanics and lower unexposed part of Hualalai volcanic series	Fluvial conglomerates Hawi volcanic series	Kahuku volcanic series	Hilina volcanic series	Hamakua volcanic series
Early Pleistocene		**Great erosional unconformity** Pololu volcanic series	**Great erosional unconformity** Ninole volcanic series		

Note: The volcanic rocks of Mauna Loa, Mauna Kea, and Hualalai, those of Mauna Kea and Kohala, and those of Mauna Loa and Kilauea interfinger.

Source: Stearns, H.T., Geology of the State of Hawaii, 1966.



LEGEND

rKFD	KEAUKAHA EXTREMELY ROCKY MUCK, 6 TO 20% SLOPES.
rPAE	PAPAI EXTREMELY STONY MUCK, 3 TO 25% SLOPES.

0 1000 2000
SCALE IN FEET

SOURCE: USGS 7.5' TOPOGRAPHIC MAP, HILO, HAWAII, 1981, AND MODIFIED FROM SOIL CONSERVATION SERVICE SOIL SURVEY OF ISLAND OF HAWAII, 1973.

FIGURE 3.3

LYMAN\SOIL

SOILS MAP
291st Combat Communications Squadron
Radar Pad at General Lyman Field
Hilo, Hawaii

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storms. Most fresh groundwater is stored near and below sea level to depths ranging to 1,000 feet or more below sea level. Water levels in wells rise and fall in response not only to general pumping and to rainfall variations, but also to changes in barometric pressure, the tides, and to earthquakes.

The principal fresh groundwater reservoirs consist of thin-bedded basaltic lava flows; the permeability of basalts exceeds that of most other rocks on earth. The potential yield from basalts is due to interstitial spaces in the basalt, cavities between beds, shrinkage cracks, lava tubes, and gas vesicles. Some lava tubes are 30 feet in diameter and, where they occur in the zone of saturation, are capable of transmitting vast quantities of water. The groundwater reservoirs contain interconnected water bodies that are impounded by dikes in the interior of the islands or are in dynamic equilibrium with the underlying saline groundwater in the outer rims of the islands. Groundwater in these settings is referred to, respectively, as dike-impounded water and basal water. The basal-water lens is maintained by recharge, which, if reduced, leads to thinning of the lens and subsequent encroachment of seawater. Seawater is the biggest pollutant of fresh water, and many of the islands' groundwater problems are, in some way, associated with the encroachment of saline water induced by development. (Stearns, 1966; and Takasaki, 1978)

Groundwater development is generally most favorable in areas directly downslope from mountain areas of high rainfall and becomes less favorable with increasing distance away from these downslope areas. The Mauna Loa lavas are considered a very large, little-tapped source of groundwater, with good potential for additional development in inland areas of higher elevation. Estimated quantities of groundwater recharge and withdrawals from the hydrographic area in which Hilo is located are shown in Figure 3.1.

Groundwater underlying General Lyman Field and the entire South Hilo area occurs as basal water in the highly permeable Kau volcanic series lavas. However, due to the site's proximity to the ocean, area groundwater may be brackish. A well test on two former wells within a 1-mile radius of the site revealed salinity readings of 300 parts per million (ppm).

There are no active drinking water wells located within a one-mile radius of the 291st CBCS radar pad. Information obtained from the Hawaii Department of Health, Safe Drinking Water Branch and the County Water Department revealed that two former drinking water wells, located approximately 4,000 feet south of the radar pad, were built in 1944 by the U.S. Navy. These water wells supplied the U.S. Army and U.S. Naval Station facilities located at General Lyman

Field during World War II (see Table 3.2). The wells were drilled to 55 and 76 feet below ground surface. When the wells were active, one well pumped 900 gallons per minute (gpm), while the second well pumped 1,000 gpm, and static water levels were measured at 4 and 5 feet above sea level. A 500,000-gallon water storage tank and pumping station were also located in close proximity to the wells. Both wells were closed in the 1950s when, due to the large volumes of water consumed by the military facilities, the aquifer was depleted and saline water encroached.

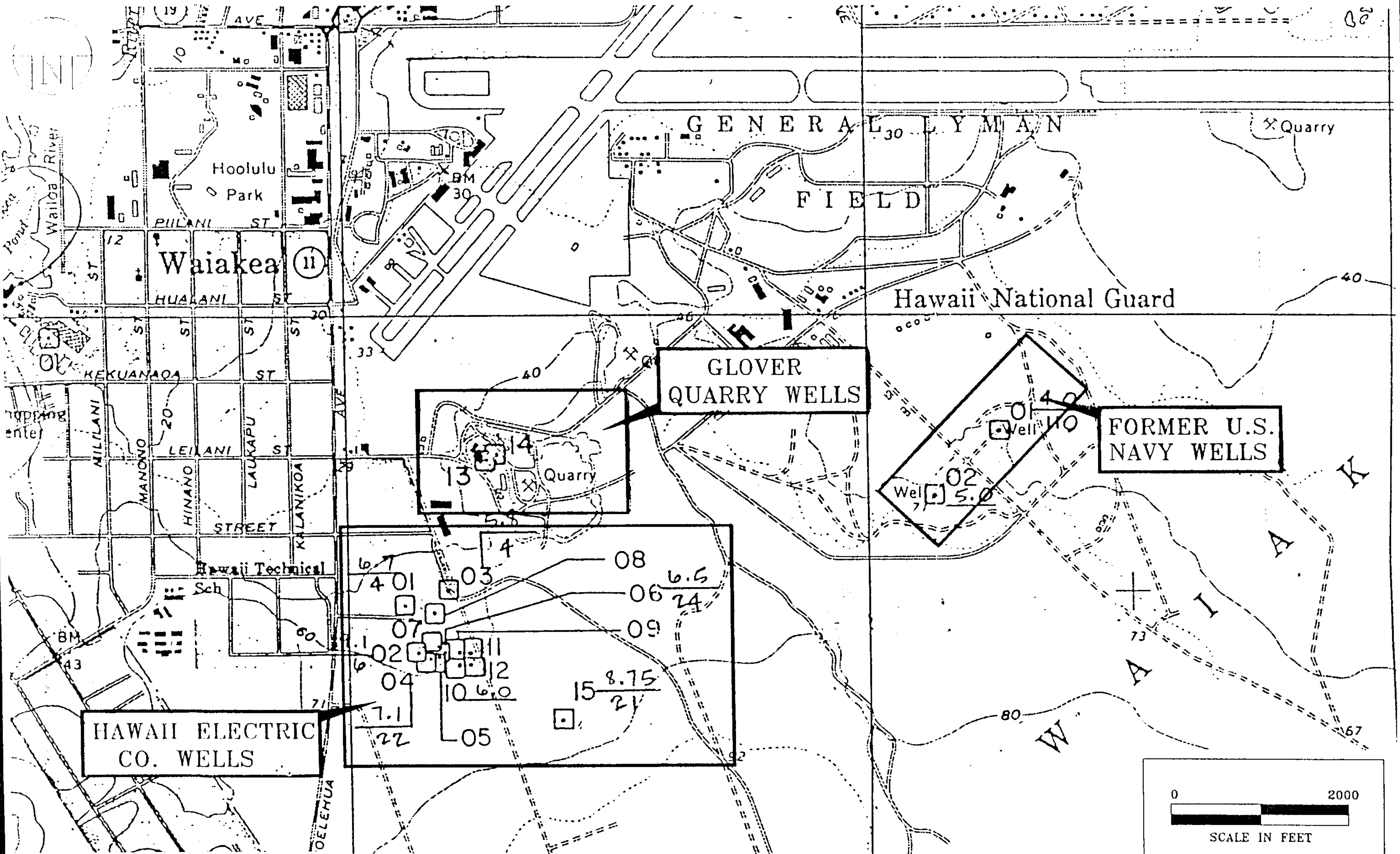
The closest drinking water supply well is located in Panaewa, approximately four miles southwest of the radar pad. Information on water wells located in the area of General Lyman Field is provided in Table 3.2, and locations of the wells are shown in Figure 3.4.

3.4.2 Surface Water

Where rainfall is plentiful and well distributed during the year, as in the wet interior mountains, streams are generally perennial and abundant. However, most streams in the islands are very flashy and the greater number are ephemeral except those draining eroded dike complexes or areas of perched groundwater. The permeability of the younger volcanoes is so great that no runoff occurs, and no well-defined stream channels exist even though rainfall may exceed 200 inches per year. In the State of Hawaii, surface water is so undependable that only a few small hydroelectric plants are operated on Kauai and Hawaii.

According to an appraisal of groundwater resources in the Hilo area, groundwater reserves are a large, little-tapped source, and thus surface water is not commonly utilized except for irrigation. Water used for irrigation is stored in small reservoirs and in a complex of tunnel and ditch systems used to carry water to crops. Rainfall is quickly absorbed by the permeable soil, and there is no runoff to any surface water source in the area of the radar pad.

Although not located in the immediate area of the radar pad, a number of small ponds and marshy areas are located in close proximity to the bayfronts of Hilo and Puhi Bays, and several rivers and streams, which originate in the steep mountains west of Hilo, empty into Hilo Bay (see Figure 3.5). (National Wetlands Inventory, U.S. Department of the Interior, Fish and Wildlife Service)



Source: Hawaii Department of Health, Safe Drinking Water Branch, 1994

FIGURE 3.4

LYMAN\RADARPAD

LOCATION OF WATER WELLS IN AREA OF RADAR PAD AT GENERAL LYMAN FIELD
291st Combat Communications Squadron
Radar Pad at General Lyman Field
Hilo, Hawaii

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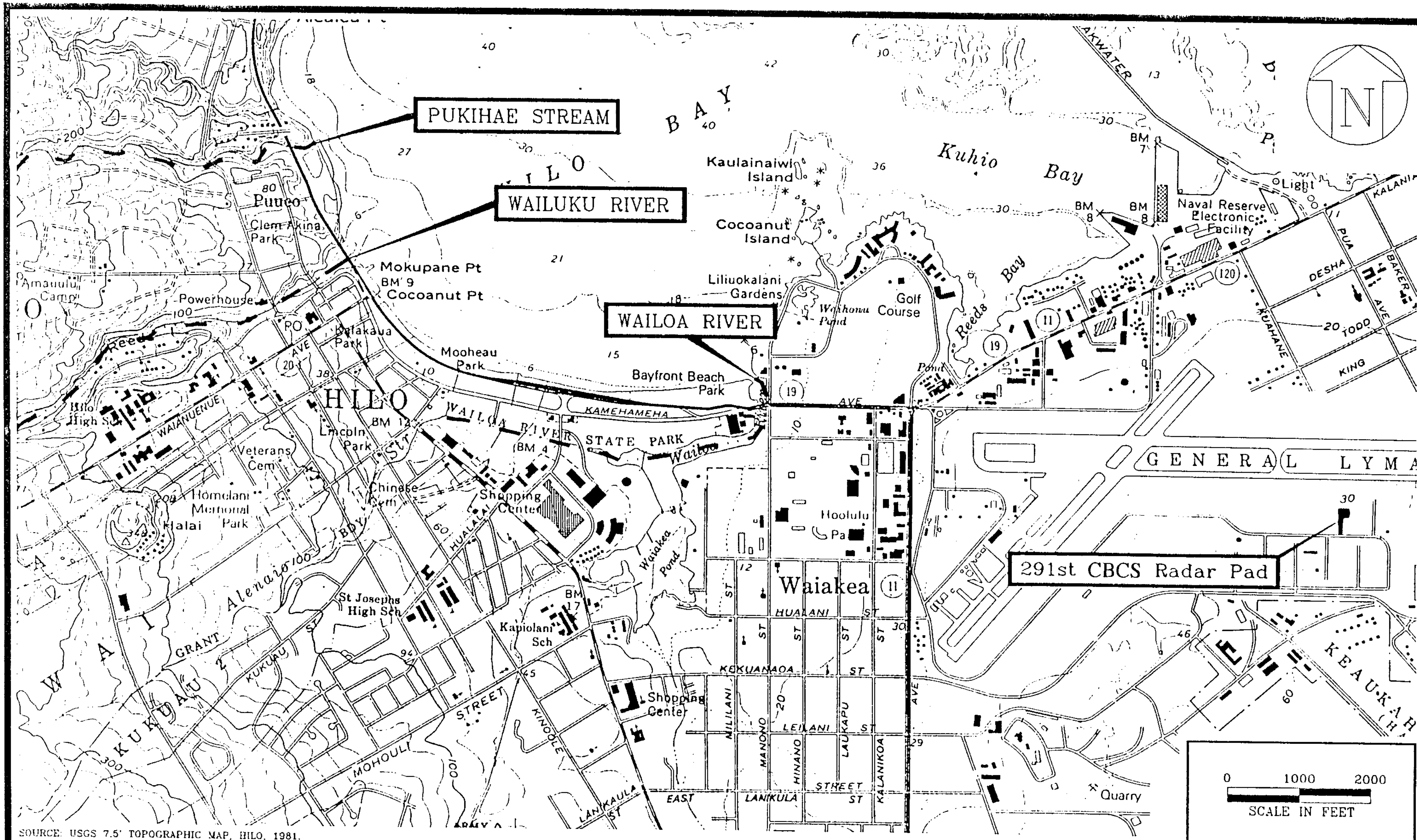

SOURCE: USGS 7.5' TOPOGRAPHIC MAP, HILO, 1981.

FIGURE 3.5

LYMAN\SURF

SURFACE WATER MAP

291st Combat Communications Squadron
Radar Pad at General Lyman Field
Hilo, Hawaii

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Table 3.2
Information on Water Wells in the Area of the Radar Pad at General Lyman Field
Hilo, Hawaii

Well Number	Well Description	Total Depth (feet)	Static Water Level (feet AMSL)	Pumping Rate[1] (gpm)	Well Use/ Status
8-4202-01	U.S. Navy	76	4	900	Unused
8-4202-02	U.S. Navy	55	5	1,000	Unused
8-4203-01	Hawaii Electric	54	6.7	36	Unused
8-4203-02	Hawaii Electric	55	9.1	50	Unused
8-4203-03	Hawaii Electric	56	5.8	50	Lost
8-4203-04	Hawaii Electric	201	7.1	4,660	Sealed
8-4203-05	Hawaii Electric	200	N/A	N/A	Industrial
8-4203-06	Hawaii Electric	200	6.5	6,500	Industrial
8-4203-07	Hawaii Electric	585	N/A	N/A	Industrial
8-4203-08	Hawaii Electric	33	N/A	N/A	Disposal
8-4203-09	Hawaii Electric	210	6.0	N/A	Industrial
8-4203-10	Hawaii Electric	210	6.0	6,100	Industrial
8-4203-11	Hawaii Electric	20	6.0	5,800	Disposal
8-4203-12	Hawaii Electric	210	6.0	6,000	Industrial
8-4203-13	Glover Quarry	25	N/A	N/A	Industrial
8-4203-14	Glover Quarry	25	N/A	N/A	Industrial
8-4203-15	Hawaiian Host	130	8.8	250	N/A

Source: State of Hawaii, Department of Health, Safe Drinking Water Branch and Department of Land and Natural Resources, Commission on Water Resource Management

[1] Maximum test pumping rate in gallons per minute.

AMSL – Above mean sea level.
N/A – Information not available.

3.5 CRITICAL HABITATS/ENDANGERED OR THREATENED SPECIES

As stated in both the Final Environmental Impact Statement conducted prior to the construction of a passenger terminal at General Lyman Field, and the DERP Inventory Project Report for Formerly Used Sites, there are no known rare or endangered species which inhabit the area.

During the site visit conducted for the Inventory Project Report in November, 1990, evidence of feral pigs was noted, and various species of urban birds were observed. Flora noted during the site visit consisted of screwpine, banyan, coconut palm, and numerous ferns and grasses.

According to the U. S. Fish and Wildlife Service, Pacific Islands Ecoregion, however, the following endangered species may exist within an approximate 5-mile radius of the radar pad:

Species	**Remarks**
Mammal	
Hoary bat	Last sighted in area in 1992
Birds	
Hawaiian coot	Last sighted in area in 1989
Hawaiian duck	Last sighted in area in 1990
Hawaiian hawk	Last sighted in area in 1992
O'u	Extremely rare; last noted in the area in 1878
Invertebrates	
Orange black megalagrion damselfly	Candidate for endangered listing; occurs in marshes and pools near Hilo Airport
Plants	
Asplenium fragile var. *insulare*	Last sighted in the area in 1910
Hilo ischaemum (*Ischaemum byrone*)	Last sighted in the area in 1992
Stenogyne angustifolia	Last sighted in the area in the 1800s
Kihi (*Adenophorus periens*)	Candidate for endangered listing; last sighted in the area in 1889

Based on surveys conducted in 1990 by the State of Hawaii, three waterways within a 5-mile radius--Pukihae Stream, the Wailuku River, and the Wailoa River (see Figure 3.5)--contain the native freshwater goby *Awaous stamineus*, and Pukihae Stream and the Wailuku River also contain the native freshwater goby *Sicyopterus stimpsoni*.

The Pacific Ocean lies less than a mile from the radar pad at General Lyman Field, and species which may be found in the marine environment near the area include the threatened green turtle *Chelonia mydas*, and endangered hawksbill turtles (*Eretmochelys imbricata*), Hawaiian monk seals (*Monachus schauinslandi*), and humpback whales (*Megaptera novaeangliae*). Because the radar pad is relatively far removed from the marine environment, no effect to any listed species as a result of activities conducted at the radar pad is anticipated. (National Fisheries Service)

4.0 AOC EVALUATION

4.1 BACKGROUND WASTE GENERATION

A review of available historic records and interviews with personnel at Hickam AFB and Hilo ANGS resulted in a description of the historic use of the 291st CBCS radar pad facility located at General Lyman Field and possible waste generation and/or disposal onsite.

4.2 AOC DESCRIPTION, EVALUATION AND HAZARD ASSESSMENT

The 19,250-square-foot concrete radar pad is located on property owned by the State of Hawaii Department of Transportation, Airports Division. It is located at the end of a secured-access service road just south of the airport's east/west runway. The radar pad was frequently utilized as a ground control access training site for approximately nine years. However, the Squadron's mission does not currently include air traffic control, and the radar pad is used only occasionally for training purposes. The radar pad contains no developed features and is currently in a state of disrepair. During unit training exercises, sanitation facilities are provided by a leased portable toilet. However, electric and telephone service is available at the site; service is provided to the pad by an underground cable located in an onsite utilities easement. A small cinder-block wall, with roof overhang, is also located at the south end of the pad.

According to one interviewee, during former training exercises at the radar pad, a transformer was brought in; however, it was pulled out when the air traffic control mission ceased in early 1991. During previous training exercises, all mobile equipment and supplies were transported to and from the site, and no onsite storage or disposal of chemicals or hazardous wastes occurred.

One other interviewee reported that, during former training activities at the radar pad, approximately 5 gallons of copper sulfate were spread along the edges of the pad every two weeks to increase the electrical grounding efficiency for the unit's mission radar. No other confirmation of this usage was noted. There have been no known spills of hazardous materials at the site, nor was any evidence of illegal dumping, ground or concrete staining, or distressed vegetation noted at the site.

During World War II, the concrete radar pad site was the foundation of a U.S. Army mess hall, designated Building A300, on Wright Avenue just south of the east/west runway of the airfield. Ten small indentations, thought to be utilized for roof supports of the mess hall, are still evident on the concrete foundation. For the complete World War II period, the site and surrounding area consisted of living quarters for Army personnel, including barracks, latrines, and mess halls. As such, storage and/or disposal of hazardous materials or substances would appear unlikely.

In addition to personnel interviews, historical information on the pad included an environmental impact assessment, a DERP inventory project report for formerly used sites on General Lyman Field facilities, and site maps and aerial photographs from several periods throughout its history. Review of historical and environmental records, the site visit, and interviews with personnel familiar with the site revealed no activities at the radar pad, or in the immediate area, which would indicate potential for contamination from hazardous wastes.

As a result of interviews with knowledgeable personnel, review of 291st CBCS records, and the site visit, a determination was made that there did not appear to be a potential for contamination from hazardous wastes at the 291st CBCS radar pad site.

4.3 OTHER PERTINENT FACTS

In 1990, the U.S. Army Corps of Engineers, Fort Shafter, Hawaii, conducted a DERP Inventory Project Report for Formerly Used Sites on General Lyman Field with a result of no identified sites which would require additional investigation and/or remediation.

SECTION 5.0 CONCLUSIONS

No AOCs will be further investigated.

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SECTION 6.0 RECOMMENDATIONS

No further IRP investigation is warranted since no formal AOCs have been identified.

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GLOSSARY OF TERMS

AA - A Hawaiian term for lava flows typified by a rough, jagged, clinkery surface.

ALLUVIAL - Pertaining to or composed of alluvium or deposited by a stream or running water.

ALLUVIUM - A general term for detrital deposits made by streams on river beds, flood plains, and alluvial fans. The term applies to stream deposits of recent time.

ANDESITE - A dark-colored, fine-grained extrusive rock.

ANNUAL PRECIPITATION - The total amount of rainfall and snowfall for the year.

AQUIFER - A body of rock that is sufficiently permeable to conduct groundwater and yield economically significant quantities of water to wells and springs.

ARTESIAN - A hydrologic condition whereby groundwater is confined, under pressure greater than atmospheric, by overlying, relatively impermeable strata.

ASH – Fine pyroclastic material (under 2.0-millimeter diameter).

BASALT - A dark-colored igneous rock, commonly extrusive, composed primarily of calcic plagioclase and pyroxene; the fine-grained equivalent of gabbro.

BASIN - (a) A depressed area with no surface outlet; (b) A drainage basin or river basin; (c) A low area in the Earth's crust, of tectonic origin, in which sediments have accumulated.

BAY - A wide, curving open indentation, recess, or inlet of a sea or lake into the land or between two capes or headlands, larger than a cove, and usually smaller than, but of the same general character as a gulf.

BED (stratigraphy) - The smallest form of a unit in the hierarchy of lithostratigraphic units. In a stratified sequence of rocks, it is distinguishable from layers above and below. A bed commonly ranges from a centimeter to a few meters.

BEDDING (stratigraphy) - The arrangement of sedimentary rock in beds or layers of varying thickness and character.

BEDROCK - A general term for the rock, usually solid, that underlies soil or other unconsolidated, superficial material.

BRECCIA – A coarse-grained clastic rock composed of angular broken rock fragments held together by a mineral cement or in a fine-grained matrix.

GLOSSARY OF TERMS (Continued)

CALCAREOUS - Containing calcium carbonate. When applied to a rock name, it implies that as much as 50% of the rock is calcium carbonate.

CALDERA - A large basin-shaped volcanic depression.

CINDER CONE – A conical hill formed by the accumulation of cinders and other pyroclasts, normally of basaltic or andesitic composition.

CLASTIC - Pertaining to a rock or sediment composed principally of fragments derived from pre-existing rocks or minerals and transported some distance from their places or origin.

CLAY (soil) - A rock or mineral particle in the soil having a diameter less than 0.002 mm (*2 microns).

CLAY (geol) - a rock or mineral fragment or a detrital particle of any composition smaller than a fine silt grain, having a diameter less than 1/256 mm (4 microns).

COARSE-TEXTURED (light textured) SOIL - Sand or loamy sand.

CONFINED AQUIFER - An aquifer bounded above and below by impermeable beds, or by beds of distinctly lower permeability than that of the aquifer itself.

CONGLOMERATE - A coarse-grained sedimentary rock, composed of rounded pebbles, cobbles, and boulders, set in a fine-grained matrix of sand or silt, and commonly cemented by calcium carbonate, iron oxide, silica, or hardened clay.

CONSOLIDATION - Any process whereby loosely aggregated, soft, or liquid earth materials become firm and coherent rock; specifically the solidification of a magma to form an igneous rock or the lithification of loose sediment to form a sedimentary rock.

CONTAMINANT - As defined by Section 101(f)(33) of Superfund Amendments and Reauthorization Act of 1986 (SARA) shall include, but is not limited to any element, substance compound, or mixture, including disease-causing agents, which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly be ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction), or physical deformation in such organisms of their offspring; except that the term "contaminant" shall not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under:

(a) any substance designated pursuant to Section 311(b)(2)(A) of the Federal Water Pollution Control Act,

(b) any element, compound, mixture, solution, or substance designated pursuant to Section 102 of this Act,

(c) any hazardous waste having the characteristics identified under or listed pursuant to Section 3001 of the Solid Waste Disposal Act (but not including any waste the regulation of which under the Solid Waste Disposal Act has been suspended by Act of Congress),

(d) any toxic pollutant listed under Section 307(a) of the Federal Water Pollution Control Act,

(e) any hazardous air pollutant listed under Section 112 of the Clean Air Act, and

(f) any imminently hazardous chemical substance or mixture with respect to which the administrator has taken action pursuant to Section 7 of the Toxic Substance Control Act:

and shall not include natural gas, liquified natural gas, or synthetic gas of pipeline quality (or mixtures of natural gas and such synthetic gas).

CORAL REEF - A coral-algal or coral-dominated mound or ridge of in-place coral colonies and skeletal fragments, carbonate sand, and organically secreted calcium carbonate.

CRITICAL HABITAT - The specific areas within the geographical area occupied by the species on which are found those physical or biological features (1) essential to the conservation of the species, and (2) which may require special management consideration or protection.

DEPOSITS - Earth material of any type, either consolidated or unconsolidated, that has accumulated by some natural process or agent.

DIKE - A tabular body of igneous rock that cuts across the structure of adjacent rocks or cuts massive rocks.

DRAINAGE CLASS (natural) - Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained - Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained - Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well-drained - Water is removed from the soil somewhat readily, but not rapidly. it is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well-drained soils are commonly medium textures. They are mainly free of mottling.

Moderately well drained - Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the soil, or periodically receive high rainfall or both.

Somewhat poorly drained - Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained - Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough periods during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very Poorly drained - Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

GLOSSARY OF TERMS (Continued)

DRAINAGEWAY - A channel of course along which water moves in draining an area.

DUST (volc) – A synonym of volcanic ash, especially the finer fractions of ash.

ENDANGERED SPECIES - Any species which is in danger of extinction throughout all or a significant portion of its range, other than a species of the Class Insecta determined by the secretary to constitute a pest whose protection would present an overwhelming and overriding risk to man.

EROSION - The general process or the group of processes whereby the materials of the earth's crust are loosened, dissolved, or worn away, and simultaneously moved from one place to another by natural agencies, but usually exclude mass wasting.

ERUPTION - The ejection of volcanic materials (lava, pyroclasts, and volcanic gases) onto the earth's surface, either from a central vent or from a fissure or group of fissures.

FAULT - A fracture or fracture zone along which there has been displacement of the sides relative to one another parallel to the fracture.

FELDSPAR - A group of abundant rock-forming minerals; the group is the most widespread of any mineral group and may constitute 60% of the earth's crust, occurring in all types of rock.

FINE-GRAINED - Said of a soil in which silt and/or clay predominate.

FINE-TEXTURED SOIL - Sandy clay, silty clay, and clay.

FLOOD PLAIN - That portion of a river valley, adjacent to the channel, which is built of sediments deposited during the present regimen of the stream and is covered with water when the river overflows its banks at flood stage.

FOLD - A curve or bed of a planar structure such as rock strata, bedding planes, foliation or cleavage.

FORMATION - A lithologically distinctive, mappable body of rock.

FRACTURE (structural geology) - A general term for any break in a rock, whether or not it causes displacement, due to mechanical failure be stress. Fracture includes crack, joints, and faults.

GABBRO - A group of dark-colored, basic intrusive igneous rocks composed principally of basic plagioclase; approximate intrusive equivalent of basalt.

GLOSSARY OF TERMS (Continued)

GEOLOGIC TIME - See Figure GL.1.

GRABEN – An elongate, relatively depressed crustal unit or block that is bounded by faults on its long sides; it may also be known as a "rift valley."

GRAVEL - An unconsolidated, natural accumulation of rounded rock fragments resulting from erosion, consisting predominantly of particles larger than sand, such as boulders, cobbles, pebbles, granules or any combination of these fragments.

GROUNDWATER - Refers to the subsurface water that occurs beneath the water table in soils and geologic formations that are fully saturated.

GROUNDWATER DRAFT – Groundwater withdrawn from the subsurface.

HAZARDOUS MATERIAL - Any substance or mixture of substances having properties capable of producing adverse effects on the health and safety of the human being. Specific regulatory definitions also found in OSHA and DOT rules.

HAZARDOUS SUBSTANCE - CERCLA hazardous substances, pollutants, and contaminant as defined in CERCLA sections 101(14) and 101(33).

HAZARDOUS WASTE - A solid or liquid waste that, because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause, or significantly contribute to, an increase in mortality or an increase in serious or incapacitating reversible illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

HYDRAULIC CONDUCTIVITY – The capacity of a rock to transmit water.

IGNEOUS ROCKS - Rock or mineral that has solidified from molten or partially molten material; i.e., from magma.

INJECTION WELL - A well into which subsurface disposal of fluid or fluids occurs or is intended to occur by means of injection.

LAGOON – A shallow stretch of seawater, such as a sound, channel, bay, or saltwater lake, near or communicating with the sea and partly or completely separated from it by a low, narrow, elongate strip of such such as a reef, barrier island, sandbank, or spit, especially the sheet of water between an offshore coral reef and the mainland.

EON	ERA	PERIOD		EPOCH	
PHANEROZOIC	CENOZOIC	QUATERNARY		HOLOCENE	
				PLEISTOCENE	2
		TERTIARY	NEOGENE	PLIOCENE	5
				MIOCENE	24
			PALEOGENE	OLIGOCENE	37
				EOCENE	58
				PALEOCENE	66
	MESOZOIC	CRETACEOUS			144
		JURASSIC			208
		TRIASSIC			254
	PALEOZOIC	PERMIAN			286
		PENNSYLVANIAN			320
		MISSISSIPPIAN			360
		DEVONIAN			408
		SILURIAN			438
		ORDOVICIAN			505
		CAMBRIAN			570
PRECAMBRIAN	PROTEROZOIC ERA				2500
	ARCHEAN EON				3800
	NO RECORD				

NOTE: NUMBERS ARE IN MILLIONS OF YEARS BEFORE THE PRESENT

FIGURE GL-1

THE GEOLOGICAL TIME SCALE

291st Combat Communications Squadron
Radar Pad at General Lyman Field
Hilo, Hawaii

GLOSSARY OF TERMS (Continued)

LAVA - Fluid rock that issues from a volcano or fissure; also, the same material solidified by cooling.

LITHOLOGY - (a) The description of rocks. (b) The physical character of a rock.

LOWLAND - A general term for low-lying land or an extensive region of low land, especially near the coast and including the extended plains or country lying not far above tide level.

MAGMA - Naturally occurring molten rock material, generated within the earth and capable of intrusion and extrusion, from which igneous rocks have been derived through solidification and related processes.

MANTLE – The zone of Earth below the crust and above the core.

MARSH - A water-saturated, poorly drained area, intermittently or permanently water-covered, having aquatic and grasslike vegetation, essentially without the formation of peat.

METAMORPHIC ROCK - Any rock derived from pre-existing rocks by mineralogical, chemical, and/or structural changes in response to changes in temperature, pressure, shearing stress, and chemical environment, generally at depth in the earth's crust.

MIGRATION (Contaminant) - The movement of contaminants through pathways (groundwater, surface water, soil, and air).

OLIVINE - A common rock-forming mineral of basic, ultrabasic, and low-silica igneous rocks (gabbro, basalt, peridotite, dunite); it crystallizes early from a magma, weathers readily at the earth's surface, and metamorphoses to serpentine.

OUTCROP - That part of a geological formation or structure that appears at the surface of the earth; also, bedrock that is covered only by surficial deposits such as alluvium.

PAHOEHOE - A Hawaiian term for basaltic lava flows typified by a smooth, billowy, or ropy surface.

PERCHED GROUNDWATER - Unconfined groundwater separated from the underlying main body of groundwater by unsaturated rock.

PERMEABILITY - The capacity of a porous rock, sediment, or soil for transmitting a fluid without impairment by the structure of the medium; it is a measure of the relative ease of fluid flow under unequal pressure.

GLOSSARY OF TERMS (Continued)

PHENOCRYSTS - One of the relatively large and ordinarily conspicuous crystals of the earliest generation in a porphyritic igneous rock.

PHREATIC EXPLOSION – A volcanic eruption or explosion of steam, mud, or other material that is not incandescent.

PHREATOMAGMATIC EXPLOSION – A volcanic explosion that extrudes both magmatic gases and steam; it is caused by the contact of magma with groundwater or shallow surface water.

POND - A natural body of standing fresh water occupying a small surface depression, usually smaller than a lake and larger than a pool.

POROSITY - The ratio of the aggregate volume of interstices in a rock or soil to its total volume.

PORPHYRITIC - A textural term for those igneous rocks in which larger crystals (phenocrysts or insets) are set in a finer groundmass which may be crystalline or glassy, or both.

POTENTIOMETRIC SURFACE - An imaginary surface representing the total head of groundwater and defined by the level to which water will rise in a well. The water table is a particular potentiometric surface.

PYROCLAST – An individual particle ejected during a volcanic eruption.

RIFT ZONE - A system of crustal fractures and faults.

RIVER - A general term for a natural freshwater surface stream of considerable volume and a permanent or seasonal flow, moving in a defined channel toward a sea, lake, or another river.

ROCK – Any naturally formed, consolidated or unconsolidated material (but not soil) consisting of two or more minerals.

RUNOFF - The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff.

SALINE (adj) - Salty; containing dissolved sodium chloride.

SAND - A rock or mineral particle in the soil, having a diameter in the range 0.52 - 2mm.

GLOSSARY OF TERMS (Continued)

SEDIMENT - Solid fragmental material that originates from weathering of rocks and is transported or deposited by air, water, or ice, or that accumulates by other natural agents, such as chemical precipitation from solution or secretion by organisms, and that forms in layers on the earth's surface at ordinary temperatures in a loose, unconsolidated form; (b) strictly solid material that has settled down from a state of suspension in a liquid.

SEDIMENTARY ROCK - A rock resulting from the consolidation of loose sediment that has accumulated in layers; e.g., a clastic rock (such as conglomerate or tillite) consisting of mechanically formed fragments of older rock transported from its source and deposited in water or from air or ice; or a chemical rock (such as rock salt or gypsum) formed by precipitation from solution; or an organic rock (such as certain limestones) consisting of the remains or secretions of plants and animals.

SEISMIC – Pertaining to an earthquake.

SILT (soil) - (a) A rock or mineral particle in the soil, having a diameter in the range 0.002-0.005 mm; (b) A soil containing more than 80% silt-sized particles, less than 12% clay, and less than 20% sand.

SITE - Area(s) where a hazardous substance has been deposited, stored, disposed, or placed, or has otherwise come to be located. Such areas may include multiple sources and may include areas between sources.

SOIL PERMEABILITY - The characteristics of the soil that enables water to move downward through the profile. Permeability is measured as the distance per unit time that water moves downward through the saturated soil.

Terms describing permeability are:

Very Slow -	less than 0.06 inches per hour (less than 4.24×10^{-5} cm/sec)
Slow -	0.06 to 0.20 inches per hour (4.24×10^{-5} to 1.41×10^{-4} cm/sec)
Moderately Slow -	0.20 to 0.63 inches per hour (1.41×10^{-4} to 4.45×10^{-4} cm/sec)
Moderate -	0.63 to 2.00 inches per hour (4.45×10^{-4} to 1.41×10^{-3} cm/sec)
Moderately Rapid -	2.00 to 6.00 inches per hour (1.41×10^{-3} to 4.24×10^{-3} cm/sec)
Rapid -	6.00 to 20.00 inches per hour (4.24×10^{-3} to 1.41×10^{-2} cm/sec)
Very Rapid -	more than 20.00 inches per hour (more than 1.41×10^{-2} cm/sec)

(Reference: U.S.D.A. Soil Conservation Service)

GLOSSARY OF TERMS (Continued)

SOIL REACTION - The degree of acidity of alkalinity of a soil, expresses in pH values. A soil that tests of pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as:

Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 to higher

SOIL STRUCTURE - The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are - platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

SOLVENTS - A substance, generally a liquid, capable of dissolving other substances.

SOURCE - Any area where a hazardous substance has been deposited, stored, disposed, or placed, plus those soils that have become contaminated from migration of a hazardous substance. Sources do not include those volumes of air, groundwater, surface water, or surface water sediments that have become contaminated by migration, except: in the case of either a groundwater plume with no identified source or contaminated surface water sediments with no identified source, the plume may be considered a source.

STONE - A general term for rock that is used for construction, either crushed for use as aggregate or cut into shaped blocks as dimension stone.

STRATIFIED - Formed, arranged, or laid down on layers or strata; especially said of any layered sedimentary rock or deposit.

STRATIGRAPHIC UNIT - A body of strata recognized as a unit for description, mapping, or correlation.

STRUCTURAL - Of or pertaining to rock deformation or to features that result from it.

GLOSSARY OF TERMS (Continued)

SURFACE WATER - All water exposed at the ground surface, including streams, rivers, ponds, and lakes.

SWALE - A slight depression, sometimes swampy, in the midst of generally level land.

SWAMP - An area intermittently or permanently covered with water, having shrubs and trees but essentially without the accumulation of peat.

THREATENED SPECIES - Any species which is likely to become an endangered species within the foreseeable future throughout all or significant portions of its range.

TIME (geologic) - See Figure Gl.1.

TOPOGRAPHY - The general conformation of a land surface, including its relief and the position of its natural and man-made features.

TSUNAMI - A great sea wave produced by a submarine earthquake or volcanic eruption (commonly and erroneously known as a "tidal wave").

TUFF – A general term for all consolidated pyroclastic rocks.

UNCONSOLIDATED - (a) Sediment that is loosely arranged or unstratified, or whose particles are not cemented together, occurring either on the surface or at depth. (b) Soil material that is in a loosely aggregated form.

UNDULATING (geomorph) - (a) A landform having a wavy outline or form. (b) A rippling or scalloped land surface, having a wavy outline or appearance.

VALLEY - Any low-lying land bordered by higher ground, especially an elongated, relatively large, gently sloping depression of the earth's surface, commonly situated between two mountains or between ranges of hills and mountains, and often containing a stream or river with an outlet. It is usually developed by stream or river erosion, but can be formed by faulting.

VEIN (intrusive rock) - A thin, sheetlike igneous intrusion into a fissure.

VESICLE - A small cavity in an aphanitic or glassy igneous rock, formed by the expansion of a bubble of gas or steam during the solidification of the rock.

VITRIC – Said of pyroclastic material that is characteristically glassy; i.e., contains more than 75% glass.

GLOSSARY OF TERMS (Concluded)

VOLCANO - A vent in the surface of the earth through which magma and associated gases and ash erupt; also, the form or structure, usually conical, that is produced by the ejected material.

WASTE DISPOSAL SYSTEM - An excavation in the ground receiving wastes which functions by allowing fluids to seep through its bottom, sides, or both, including cesspools, septic tanks, and seepage pits.

WATER TABLE - The upper limit of the portion of the ground that is wholly saturated with water; the surface on which the fluid pressure in the pores of a porous medium is exactly atmospheric.

WETLANDS - Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

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APPENDIX A

OUTSIDE AGENCIES CONTACTED

APPENDIX A

OUTSIDE AGENCIES CONTACTED

State of Hawaii
Department of Health
Environmental Management Division
Safe Drinking Water Branch
919 Ala Moana Boulevard
Honolulu, Hawaii 96813
(808) 586-4258

State of Hawaii
Department of Defense
Environmental Officer
3949 Diamond Head Road
Honolulu, Hawaii 96816-4495
(808) 735-4659

State of Hawaii
Department of Defense
Office of the Adjutant General
Contracting & Engineering Officer
3949 Diamond Head Road
Honolulu, Hawaii 96816-4495
(808) 735-3522

State of Hawaii
Department of Land and Natural Resources
Commission on Water Resource Management
Kalanimoku Building, Room 227
1151 Punchbowl Street
Honolulu, Hawaii 96809
(808) 587-0218

State of Hawaii
Office of Environmental Quality Control
Central Pacific Plaza
220 South King Street, 4th floor
Honolulu, Hawaii 96813
(808) 586-4185

OUTSIDE AGENCIES CONTACTED (Continued)

R. M. Towill Corporation
420 Waikamilo Road, Suite 411
Honolulu, Hawaii 96817-4941
(808) 842-1133

Hawaii Air National Guard
Environmental Management Office
154th Civil Engineering Squadron
360 Harbor Drive
Hickam Air Force Base, Hawaii 96853-5517
(808) 449-5711

Hawaii Air National Guard
291st Combat Communications Squadron
1300 Kekuanaoa Street
Hilo, Hawaii 96720-4568
(808) 961-6355

Hawaii Army National Guard
Fort Ruger, Hawaii
(808) 732-1574

Agency Information Consultants
1708 Guadalupe
Austin, Texas 78701
(512) 478-8991

State of Hawaii Archives
Iolani Palace Grounds
Honolulu, Hawaii
(808) 586-0329

U. S. Army Corps of Engineers
Pacific Ocean Division
Honolulu District
Fort Shafter, Hawaii 96858
(808) 438-1331

OUTSIDE AGENCIES CONTACTED (Concluded)

U.S. Department of Agriculture
Soil Conservation Service
Prince Kuhio Federal Building
Honolulu, Hawaii
(808) 541-2600

U.S. Fish and Wildlife
Pacific Islands Office
P. O. Box 50167
Honolulu, Hawaii 96850
(808) 541-2749

National Oceanic & Atmospheric Administration (NOAA)
National Fisheries Service
2570 Dole Street
Honolulu, Hawaii 96822-2396
(808) 943-1221

U.S. Department of the Interior
U.S. Geological Survey
Branch of Distribution
Box 25286
Denver Federal Center, Bldg 810
Denver, CO 80225

General Lyman Field
Property Management Office
Hilo, Hawaii
(808) 933-4782

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APPENDIX B

PHOTOGRAPHS

1. View of radar pad, looking north toward runway. Note condition of pavement.

2. View from radar pad, looking south, with airport control tower in right background.